

Durham Cathedral, Nave. (From a photo. by Mr. C. C. Hodges.)

THE BEGINNINGS OF GOTHIC ARCHITECTURE.

By JOHN BILSON [*F.*], F.S.A.

II.* NORMAN VAULTING IN ENGLAND.

Read before the Royal Institute of British Architects, Monday, 20th March 1899.

THE revival of architecture in Normandy seems to have commenced under Duke Richard II., in the early years of the eleventh century. Originally sharing the characteristics of "primitive" Romanesque in Western Europe generally, Norman Romanesque soon develops a strongly marked individuality, and, in the middle of the eleventh century, begins to show its superiority over the architecture of the neighbouring provinces.† At the time of the Conquest of England the style had not advanced very far, but it contained the germs of vigorous development. Perhaps its most striking characteristic is the strictly logical relation between arches and vaults and their supports. The design of the building is the consistent expression of its structure. There is already a pronounced tendency to accentuate the membering of pier and arch. This tendency leads naturally enough to the numerous orders into which the arches and piers are divided in the first half of the twelfth century, and at a later period to the rich arch mouldings which are so characteristic of English Gothic, even in its earliest phase. Their severely logical plans prove that the Normans aimed at nothing less than covering all parts of their churches with stone vaults. The aisles of some

* See Part I. "Review of Recent Discussion," *ante*, p. 259.

† *L'Architecture normande*, by V. Ruprich-Robert, p. 6.

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Die Kirchliche Baukunst des Abendlandes, by G. Dehio and G. von Bezold, i. 278 *et seq.*

of their churches were already so covered at the time of the Conquest, though few aisle vaults in Normandy have survived which can be assigned to an earlier date than 1050.* They had not yet succeeded in vaulting the principal spans of their churches, but a few choir vaults prove that this was accomplished before the end of the eleventh century.

We know but little of the larger English churches which immediately preceded the Norman Conquest, but the available literary evidence tends to show that some of the Norman methods were already in use. We are not justified, however, in believing that the design of these English buildings was marked by the logical precision which is so characteristic of Norman work, or that the English had taken any step in the direction of vaulting over their churches. The persistence of the tradition of the wood ceiling, which England doubtless shared with the rest of North-Western Europe, is indicated clearly enough by the great cylindrical piers of the main arcades, such as we find at Gloucester, Tewkesbury, and Southwell—a type unknown in Normandy, except in a few churches of quite minor importance. It is not unlikely that English tradition may also account for certain features in the plans of some of the larger Norman churches in England which are not to be found in those of Normandy, where there is a much closer adherence to a single type of plan. In point of detail the same tendency is marked, soon after the Conquest, by the substitution of the cushion capital for the volute capital which was then almost universally used in Normandy.†

In studying the development of vaulting as illustrated by English examples between the Norman Conquest and the middle of the twelfth century it will be convenient to deal first with the vaults of the lower parts of churches, such as aisles and crypts, not only because we have earlier examples of these vaults, but also because their consideration is not complicated by the question of abutment, which is so important a factor in the construction of vaults over

the principal spans. It is the groined vault alone which we have to consider. The Normans scarcely ever used the barrel vault over the more important parts of their churches. The barrel vault over the main span of the chapel in the Tower of London is quite an exceptional example.

The groined vault ‡ in its simplest form results from the intersection of two semi-cylindrical vaults at right angles to one another, without transverse arches—a survival, in fact, of the Roman groined vault. The nave aisles of Sainte-Trinité, Caen, are covered with vaults of this kind, which, however, occur more frequently in crypts (*e.g.* Sainte-Trinité, Caen, and Bayeux). In England we have examples of this method of vaulting in the undercroft of the refectory at Durham, constructed during the exile of bishop William of Saint-Calais

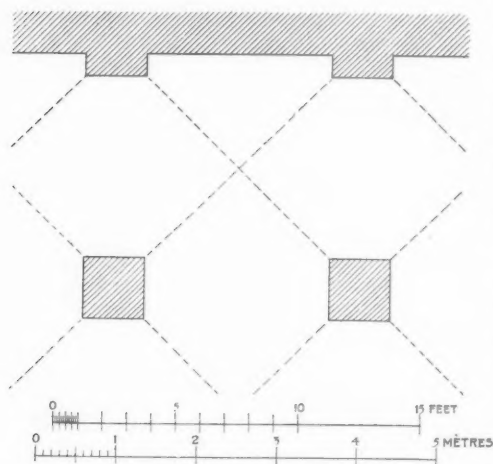


FIG. 1.—DURHAM, UNDERCROFT OF REFECTORY.

(1088–1091),§ where the vault is supported by square piers (fig. 1), and in the crypt under the

* *L'Architecture normande*, p. 60.

† In some of the earlier churches in Normandy we occasionally find cubic capitals in which the square is gradually rounded off to the circular section of the shaft, or where the angles of the square are bevelled off (as in the nave of Jumièges); but these capitals do not show the semicircular line on the face of the cushion capital so

common in England, and it is certain that capitals of the latter type were in use in England before the Conquest.

‡ I shall use the term *groined vault* to mean the groined vault without ribs, and the term *ribbed vault* as signifying the groined vault with ribs.

§ *Durham Cathedral*, by the Rev. William Greenwell, 5th ed., p. 21.

choir of Rochester Cathedral (built by bishop Gundulf, 1077-1082), where the supports are cylindrical shafts.*

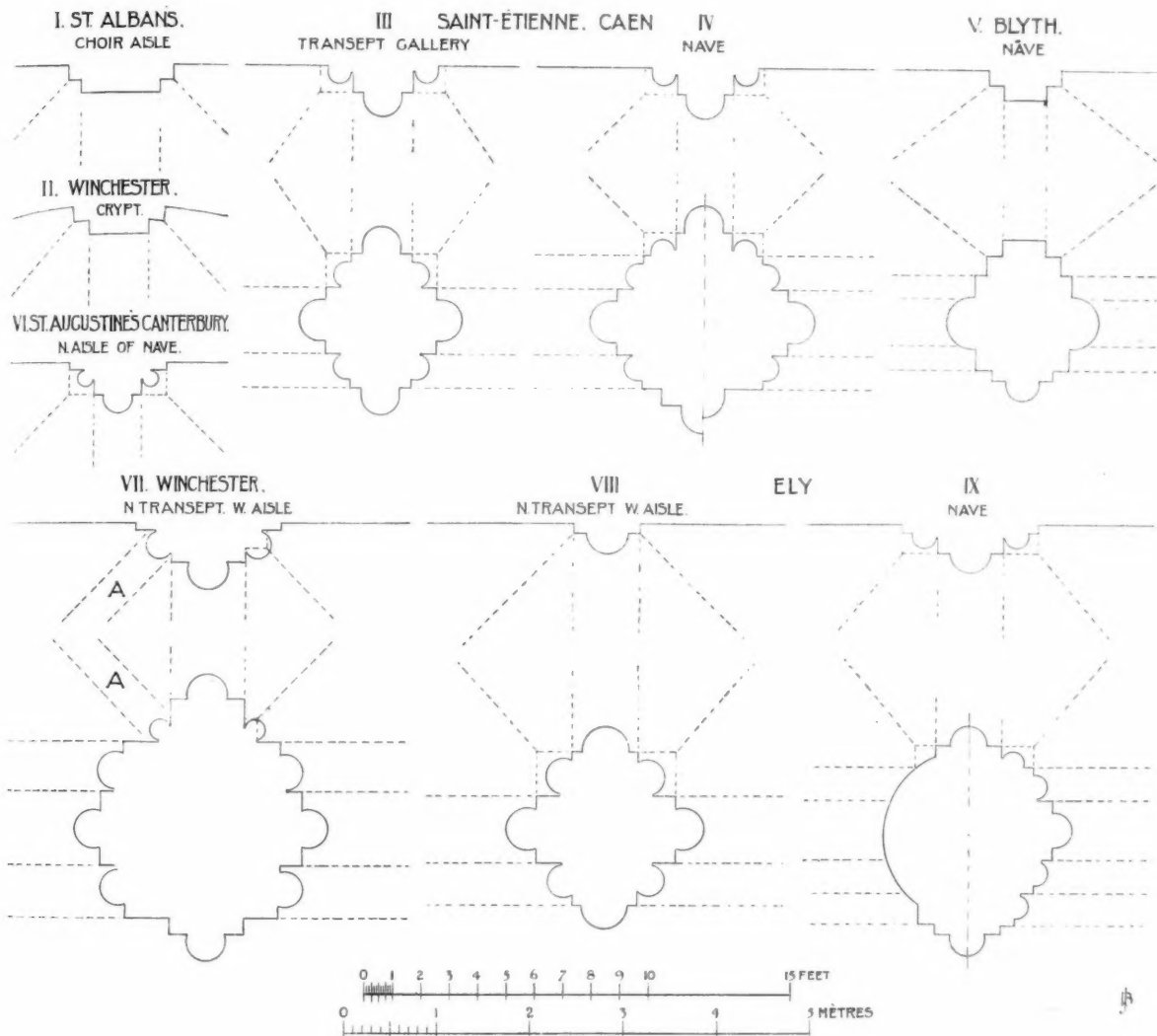


FIG. 2.- PLANS OF PIERS.

Generally, however, these groined vaults are banded by semicircular transverse arches, which are usually of simple square section, and form a kind of permanent centering to the vault.† The adoption of these transverse arches, however, involved considerable inconvenience

* Gundulf's Tower at Rochester, and the First Norman Cathedral Church there, by W. H. St. John Hope, *Archæologia*, xlix. 323.

† The boarded centering rested on the extrados of the transverse arches. In the crypt of Lastingham church, Yorkshire, this is proved by some fragments of the boarded

in the construction of the springing of the groin. In the Roman groined vault and its imitations the groin springs from the *external* angle of the pier or pilaster. In many of the early Norman vaults the groin springs either from the *internal* angle formed by the junction of the transverse arch at its springing with the wall-face, or from the face of the wall or arch close to the angle.* As the vaults were constructed of rubble masonry with thick joints and covered with plaster, this method of springing the groin was obviously defective as a matter of construction. Consequently we find the difficulty met at a very early date by a further development in the membering of the supporting pier; the pilaster which carries the transverse arch is flanked on each side by a secondary pilaster which affords an independent support for the

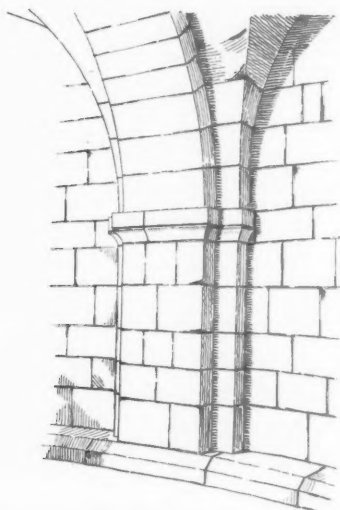


FIG. 3.—WINCHESTER, CRYPT.

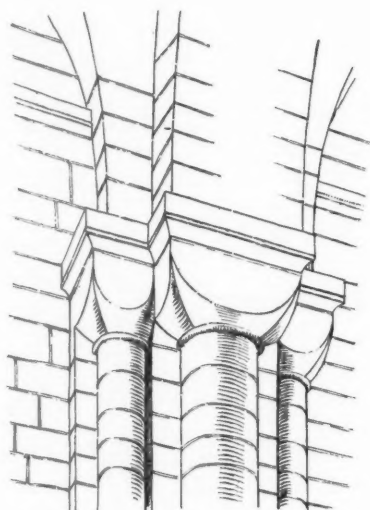


FIG. 4.—WINCHESTER, VAULT UNDER GALLERY OF NORTH TRANSEPT.

groin.† This method is followed in the undercroft of the dormitory at Westminster Abbey (a continuation of the Confessor's work, probably dating about 1070–1080), where the pier and groin are continuous without impost.‡ Other examples (with moulded impost) are the aisles of St. Albans (commenced by abbot Paul of Caen in 1077), fig. 2, i.; the crypt of Winchester Cathedral (commenced by bishop Walkelin in 1079), fig. 2, ii., and fig. 3; the aisles of the chapel in the Tower of London (c. 1080); the nave aisles of the priory church of Blyth, Nottinghamshire (founded 1088), fig. 2, v.; the crypt of Bow church, London;§ and the choir aisles of St. Bartholomew's, Smithfield, founded as late as 1123.|| In some crypts

centering which still remain. This crypt was built between 1078 and 1088 by the seceding monks from Whitby, who left the church at Lastingham unfinished, and founded the abbey of St. Mary, York.

* As in the nave aisles at Lessay (fig. 20), and in the choir and aisles of Saint-Nicolas, Caen, and Saint-Georges-de-Boscherville (fig. 24); see also the wall-pier in north transept of Ely Cathedral (fig. 2, viii.)

† The vaults in such early examples as Bernay and Jumièges already show an approach to this method. In the south choir aisle at Bernay the groin at its springing forms a projecting external angle, though the pier has no corresponding projection to receive it. In the nave aisles at

Jumièges the wall-pier is a semi-cylindrical shaft flanked by a square projection on each side (as at Ely, fig. 2, viii.); the transverse arch, however, does not occupy the full width of the pier, but leaves the angles of the pilaster free to support the external angles of the groins at their springing.

‡ This applies to the wall-piers only. Over the cylindrical columns the groin springs from the internal angle between the arches, at a little distance above the capital. The arches are segmental curves struck from centres a little below the springing line.

§ *Vetusta Monumenta*, v. plate 64.

|| In the undercroft of the dormitory at Westminster,

where the vaulting is supported by single cylindrical shafts, the springing of the vault is subdivided in a similar manner, so as to give a separate projection for the springing of the groin; e.g. the crypt of Worcester Cathedral* (1084), the crypt of Ernulf's work at Canterbury Cathedral (c. 1096), and the chapel in the castle of Durham (commenced by the Conqueror in 1072).

A further advance consisted in the substitution of a shaft for the square pilaster which supported the groin. The vaults under the transept galleries at Saint-Etienne, Caen, are supported in this manner (fig. 2, iii.), and, although the vaults of the nave aisles of this church have been reconstructed at a later date,† the plans of the piers (fig. 2, iv.) clearly show that the same method was followed there.‡ The same treatment occurs in bishop Walkelin's work in the transept aisles of Winchester Cathedral (fig. 2, vii. and fig. 4).§ We find it also in the contemporary work of abbot Simeon (Walkelin's brother) in the transept aisles of Ely Cathedral, where, however, the shaft under the groin occurs only in the main piers and not in the wall-piers (fig. 2, viii.). The vaulting of the nave aisles of Ely || follows the same method, except that the wall-piers throughout have a shaft under the groin (fig. 2, ix.), as at Winchester. In the north aisle of the nave of St. Augustine's abbey church, Canterbury, the groin is supported by a shaft (fig. 2, vi.), and Professor Willis suggests that the same treatment was adopted in the choir aisles of Ernulf's work in Canterbury Cathedral.¶ Examples of this method are not very numerous, and it is scarcely likely that it was ever extensively adopted, for it was immediately superseded by the introduction of the diagonal rib.

In the vaults under the transept galleries at Saint-Etienne, Caen, and in bishop Walkelin's work at Winchester Cathedral (both in the crypt, fig. 3, and in the transept aisles, fig. 4),** we find an improvement in the construction of the vaults themselves. The haunches of the vault, for a short distance above the springing, are constructed of ashlar, above which the vault is of rubble, plastered. These advances in the construction of the groin springing and in the treatment of its supporting pier are worthy of attention as pointing in the direction of the far more important step which was taken when the rib was introduced. But before passing to this, my main subject, I must say a word on the modification of the simple groined vault necessitated by the oblong or irregular plan of the bays to be vaulted.

Whatever the shape of the space to be covered by an unribbed vault—whether an oblong, triangle, or trapezium—the Normans always aimed at keeping the crowns of the vault approximately level.†† They accomplished this result by tilting the curves of the cells over the narrower spans. Sometimes these curves are simply stilted semicircles; sometimes the tilting lines slope inwards as they rise, so as to reduce the span of the semicircle; and more frequently the curve approaches more nearly to that of a tall semi-ellipse. The methods are irregular, for all is yet in the region of experiment. That the Normans had already, before the introduction of the rib, acquired considerable dexterity in vaulting bays of irregular plan

the aisles of the chapel in the Tower, the crypt of Bow church, and the choir aisles of St. Bartholomew's, Smithfield, the vaults are supported on the side walls by wall arches which spring from inner pilaster projections. For illustrations of the chapel in the Tower, see *Vetusta Monumenta*, iv. plates 48–51.

* An excellent analysis of the vaulting of the crypt of Worcester Cathedral, by Professor Willis, is printed in the R.I.B.A. TRANSACTIONS for 1862–3, p. 213.

† *Analyse architecturale de l'Abbaye de Saint-Etienne de Caen*, by G. Bouet, Caen, 1868, pp. 32 and 34, and *Bulletin Monumental*, xxxi. 448, 450.

‡ Also in the north aisle of nave of Saint-Taurin, Evreux.

§ So also in the angles of the central part of Gundulf's crypt at Rochester (*Archæologia*, xlix.). In the angles of

the aisles of this crypt the groins spring from a square pilaster.

|| Ruprich-Robert gives the date of the nave of Ely as 1174–1189. This can only apply to the upper part of the west end. The design of the nave must certainly be attributed to the time of abbot Richard (1100–1107), even if the greater part of it was not actually erected by him. See *The Architectural History of Ely Cathedral*, by the Rev. D. J. Stewart (1868), p. 88.

¶ *The Architectural History of Canterbury Cathedral*, by Professor Willis (1845), p. 77.

** Also in the nave aisle vaults at Blyth (Notts).

†† In England, at any rate, the Normans never appear to have adopted the expedient of raising the crown of the unribbed vault, so as to give the groin a semicircular form (Viollet-le-Duc, *Dictionnaire*, iv. 18).

is amply proved by the crypts of Winchester * and Worcester.† In the apse and ambulatory of the Winchester crypt the irregular shape of the bays and the skill exhibited in their vaulting are very remarkable. The arches are depressed curves rather lower than semi-circles,‡ while, in order to bring the crowns to the same level, the wall-cells in the narrower bays assume a very tall elliptical curve. At Gloucester Cathedral (commenced 1089, dedicated 1100), in the narrow bay on the west side of the southern apsidal chapel, the wall-arch

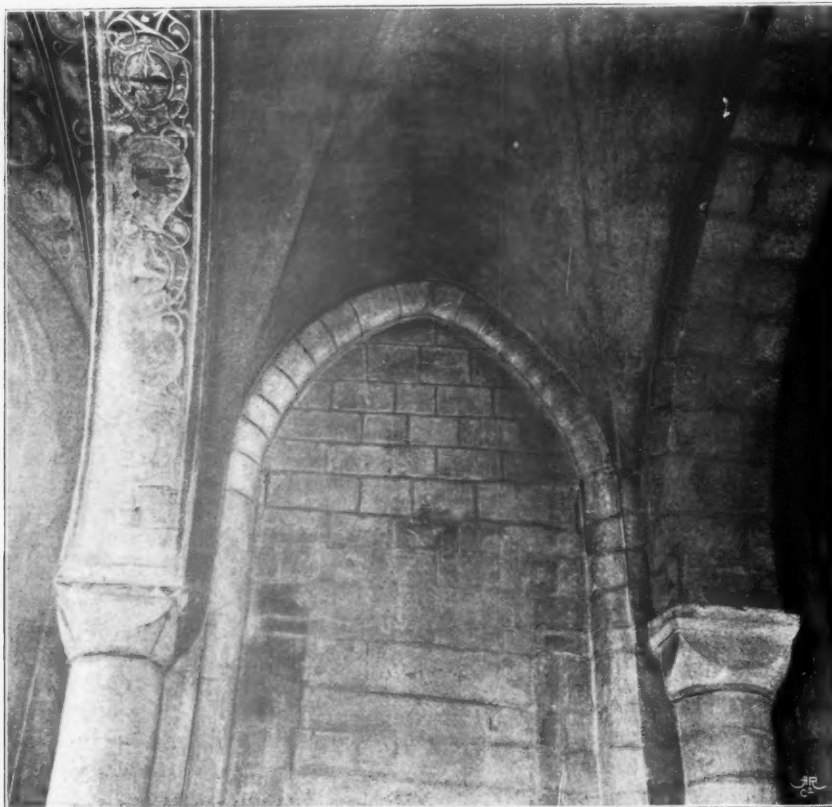


FIG. 5.—GLOUCESTER, SOUTH CHAPEL OF AMBULATORY, WEST SIDE.

is actually a pointed arch, though the vault itself is slightly rounded over at the top (fig. 5). The extreme flexibility of their treatment of the unribbed vault clearly goes far to account for the early adoption and systematic development of the rib by the Norman builders.

The tall semi-elliptical curve § assumed by the lateral cells of unribbed vaults just mentioned is worth notice, because it shows that, before the introduction of the rib, the Norman builders were already modifying the curve of the lateral cells to suit the curve of the groin.

* For plan of this crypt see Britton's *History and Antiquities of the See and Cathedral Church of Winchester* (1817), plate ii.

† Professor Willis, *ut sup.*

‡ Professor Willis speaks of them as ellipses, with a span of 15 feet and height of 6 feet. R.I.B.A. TRANSACTIONS, 1862-3, p. 215.

§ Sir G. G. Scott (*Lectures on Mediæval Architecture*, i. 57) says that this curve was adopted, if at all, in occasional cases only, but I think that the examples which exist justify the interpretation of them here suggested. Cf. Ruprich-Robert, *L'Architecture normande*, p. 71.

Let us take the case of an unribbed vault over an oblong space $ABCD$ (fig. 6), in which the curve of the vault over the longer side is a semicircle AEB , and in which the crowns of the vault are to be kept level. If the curve of the lateral cell is a stilted semicircle AFG , the groin will not lie in one vertical plane, but will assume an inflected line,* shown on plan by AN, BH . If, however, the groin is kept in one plane, represented by a straight line DN on plan, its curve will be a semi-ellipse DK , and this curve projected on the lateral wall will give a semi-elliptical curve DLG for the wall-cell. I do not suggest that these early vaults were constructed with mathematical exactness, but it seems to be clear that the elliptical curve was given to the wall-cell in order to keep the groin-line approximately in one plane. After the introduction of the rib, the wall-cells of oblong vaults generally assume the elliptical form, although in the earliest ribbed vaults the groin is no longer a semi-ellipse, but a segment of a circle struck from a centre below the springing line. The rib-curves henceforth control the construction, and the vaulting surfaces are adapted to them.

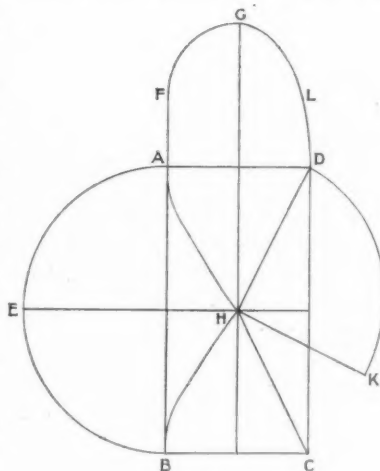


FIG. 6.

We have seen† that the ribbed vault makes its appearance towards the end of the eleventh century in districts widely separated geographically, from the north of Italy to Brittany. The history of the evolution of the rib lies outside the scope of this paper, which attempts only to deal with the story of its development in English examples. But wherever it first originated, or whatever the precise circumstances under which it was evolved, its advantage was obvious. It afforded a permanent centering for the groin, the weakness of which in vaults over wide spans must always have rendered them liable to failure. It completed the membering of the vault which had commenced when the transverse arch was added to the Roman groined vault. The Normans, before the end of the eleventh century, were already covering their choirs with simple groined vaults, of which there still remain a few examples, to be noticed presently. The introduction of the rib naturally commended itself to a school which had already shown such a decided tendency towards the multiplication of orders in arches and piers, and such skill in constructing unribbed vaults, and we need not be surprised to find that the new expedient was readily adopted and rapidly developed by the Normans, in England as well as in Normandy itself.

The cathedral church of Durham is not only the finest Romanesque building our country possesses, but it is also the most complete early example of the adoption of the ribbed vault in England. Every part of the church‡ was covered with ribbed vaulting between 1093 and 1133. The proof of this statement, in view of the discussion summarised in the first part of this paper, is clearly a matter of the first importance. Fortunately, however, the documentary evidence, so far as it goes, is beyond question, for it is recorded by contemporary chroniclers, one of whom was certainly, and the other probably, a monk of Durham. The more important passages are quoted below,§ and they enable us to fix exactly certain stages in the progress of

* See Professor Willis on the Worcester crypt vaults, R.I.B.A. TRANSACTIONS, 1862-3, p. 215 and pl. i.

† P. 261, above.

‡ Except, perhaps, the crossing, as to which we have no certain evidence, for the upper part of the central tower was rebuilt in the fifteenth century. The shafts which are carried up in each angle of the lantern were doubtless

designed to receive the diagonal ribs of the crossing vault.

§ *Symeonis Monachi Dunhelm. libellus de exordio Dunhelmensis Ecclesiae*. Ed. Thomas Bedford, London, 1732. Rolls Series, ed. T. Arnold, 1882-5. The references below are to the latter edition. Symeon's history ends in 1096, and that of his continuator in 1144.

"Ecclesiam xcvij anno ex quo ab Alduno fundata fuerat,

the building. Soon after his return from exile bishop William of Saint-Calais pulled down Aldhun's church, and in the following year he commenced the erection of a larger and nobler structure. The foundation-stones were laid on the 11th August 1093. We have no documentary evidence as to the progress of the work when bishop William died on the 6th January 1096. We learn, however, that the bishop had undertaken the erection of the church, while the monks went on with the monastic buildings, and that, when the bishop's death put an end to this agreement, the monks devoted themselves to the works of the church, which, when Ralph Flambard became bishop in 1099, had advanced as far as the nave. Considering the great resources and energetic character of bishop William, and the much more limited means of the monks, we are justified in believing, what indeed is indicated by the character of the work itself, that the choir and east side of the transepts, as far as the top of the triforium, are the bishop's work, and that the west side of the transepts must be attributed to the monks. The choir was so far completed in 1104 as to permit the translation of the body of St. Cuthbert to the shrine at the east end. Flambard proceeded with the works *modo intentius modo remissius*, and this characteristic is illustrated by certain changes of design in the nave and upper part of the south transept. When Flambard died in 1128 he had carried up the nave as far as the vault. In the interval between his death and the accession of bishop Geoffrey Rufus in 1133, the monks completed the nave (*i.e.* they constructed the vault).

The plan* of the choir and east side of the transepts of Durham shows that it was the intention from the first to cover both the aisles and the main spans with the vaults which were actually constructed. The vaulting of the main spans will be considered presently. Let us examine first the vaults of the aisles, which were constructed under bishop William between 1093 and 1096. These vaults are shown in the general drawings of one bay of the choir (figs. 7, 8, and 9†), and in the detailed plan (fig. 10), on which the curves of the ribs are developed.‡ The transverse and diagonal ribs of the vault are received by triple shafts on the aisle wall and on the back of the major and minor piers of the great arcade, each rib being supported by its own shaft. The plan of each bay of the choir aisles is a pronounced

destrui præcepit, et sequenti anno positus fundamentis nobiliori satis et majori opere aliam construere cepit. Est autem incepta M.xc.ij Dominice incarnationis anno, pontificatus autem Willelmi xij ex quo autem monachi in Dunelmum convenerant xj tertio Idus Augusti, feria v. Eo enim die Episcopus, et qui post eum secundus erat in ecclesia Prior Turgotus cum cæteris fratribus primos in fundamento lapides posuerunt. Nam paulo ante, id est, iv. Kal. Augusti feria vj, idem Episcopus et Prior, facta cum fratribus oratione ac data benedictione, fundamentum cæperant fodere. Igitur monachis suas officinas ædificantes, suis Episcopus sumptibus ecclesie opus faciebat." —*Symeon*, i. 128-9.

Of Flambard the continuator says: "Circa opus ecclesie modo intentius modo remissius agebatur, sicut illi ex oblatione altaris et cæmeterii vel suppetebat pecunia vel deficiebat. His namque sumptibus navem ecclesie circumductis parietibus, ad sui usque testudinem erexerat. Porro prædecessor [Willelmus de S. Carilefo] illius [Rannulfus], qui opus inchoavit, id decernendo statuerat, ut Episcopus ex suo ecclesiam, monachi vero suas ex ecclesie collectis facerent officinas. Quod illo cadente cecidit. Monachi enim omisissis officinarum ædificationibus operi ecclesie insistent, quam usque navem Rannulfus jam factum invenit." —*Continuatio*, i. 139-140.

After Flambard's death: "Vacavitque episcopatus per quinquennium. Eo tempore navis ecclesie Dunelmensis monachis operi instantibus peracta est." —*Continuatio*, i. 141.

* For plan of the cathedral, see *Architectural Illustrations and Description of the Cathedral Church of Durham*, by R. W. Billings, London, 1843, plates 3 and 4; and *The Builder*, lxi. 427. For plan showing the original eastern termination of the choir, see *Archæological Journal*, liii. 9 (plate 2).

† Figs. 7 to 12 all illustrate the western half of the eastern double bay of the choir (north side). On figs. 7 and 8 the existing vault of the choir, which was erected in the middle of the thirteenth century, is omitted, and a few other alterations are suppressed. The springing of the thirteenth-century vault, its wall-ribs (A, A, A), and the shafts which receive them are shown by dotted lines on fig. 7. The joints in the masonry of the clerestory at B B and C C (fig. 7) show the line of the original vault of the choir. The capitals of the triple vaulting shaft at D (fig. 7) were carved in the thirteenth century when the existing vault was constructed, but the corresponding capitals in the western double bay remain unaltered. The vaulting shaft at E (fig. 7) has been cut away for the choir stalls, which cover the face of the pier below, where no joints are shown. The present aisle floor level represents the original floor level of the choir (*Archæological Journal*, liii. 6). The north aisle windows are later insertions; that shown by dotted lines on the section at F (fig. 8) is supplied from the transept aisle. The bench table added in the north aisle by bishop Skirlaw (1388-1405) is shown by dotted lines at G (fig. 8).

‡ In the plans of vaults which illustrate this paper, the centre line of the rib on plan represents the springing line on which the rib-curve is set up.

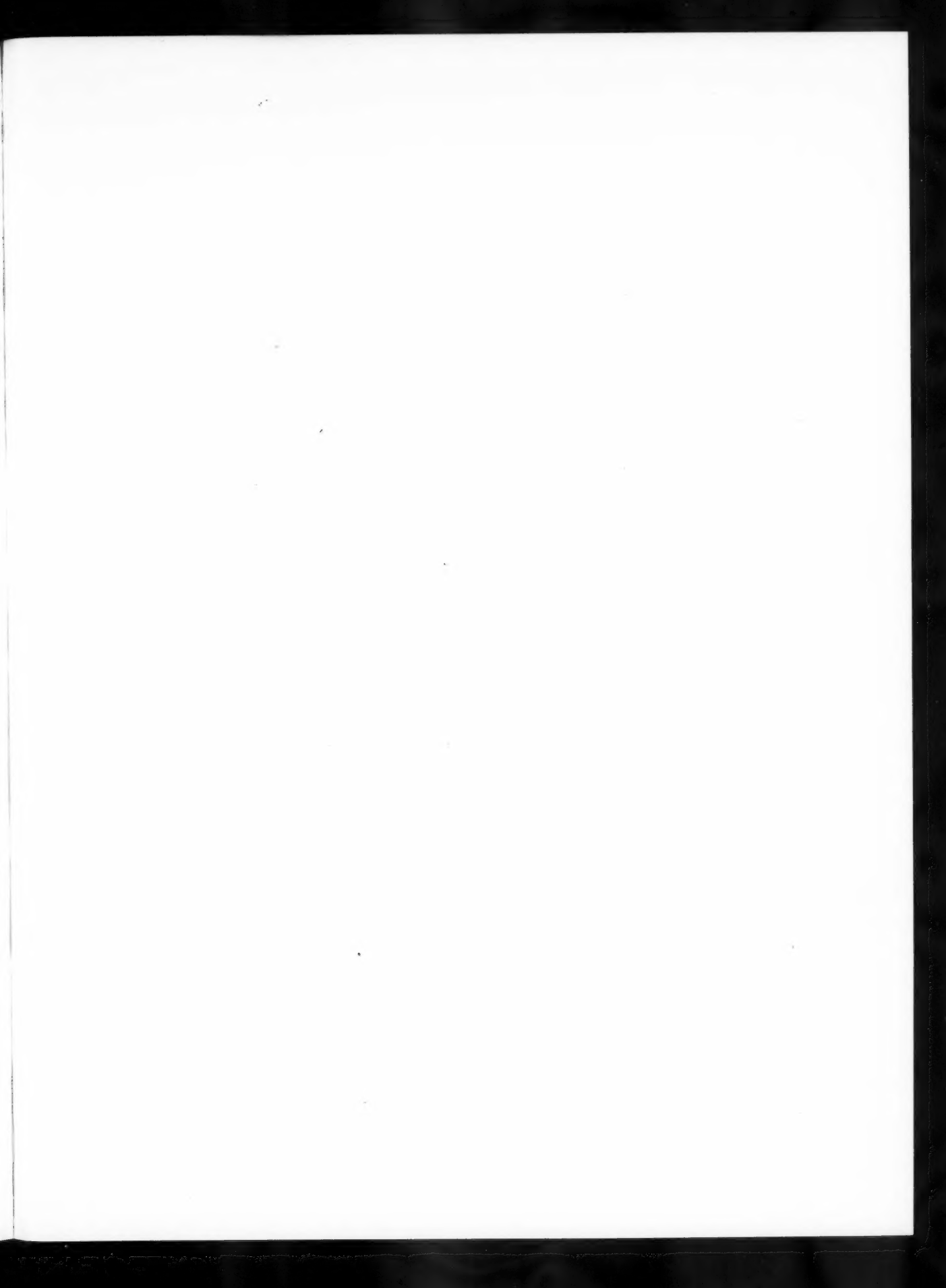


FIG. 7.

DURHAM CATHEDRAL, ELEVATION OF BAY OF CHOIR, NORTH SIDE

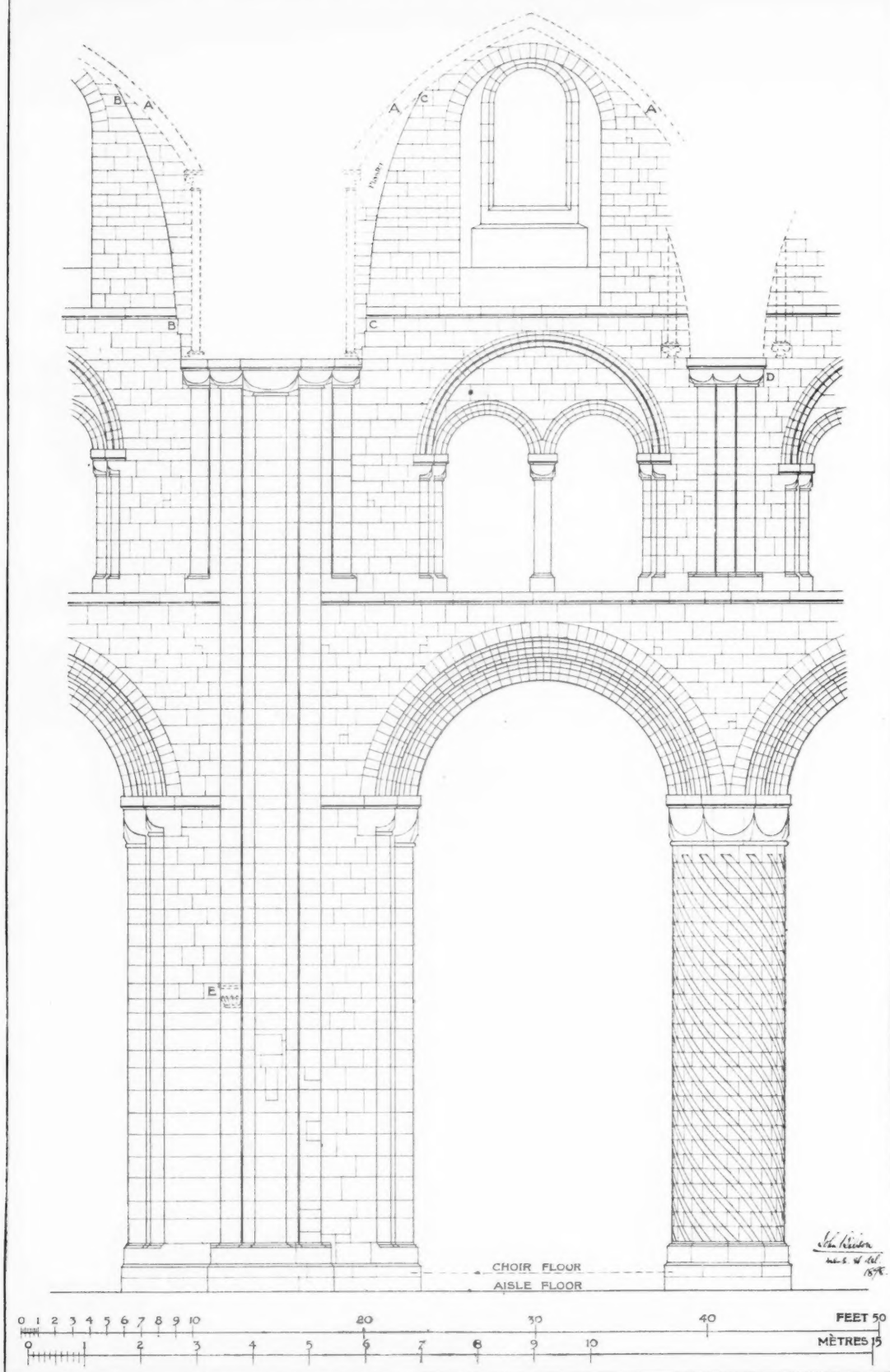
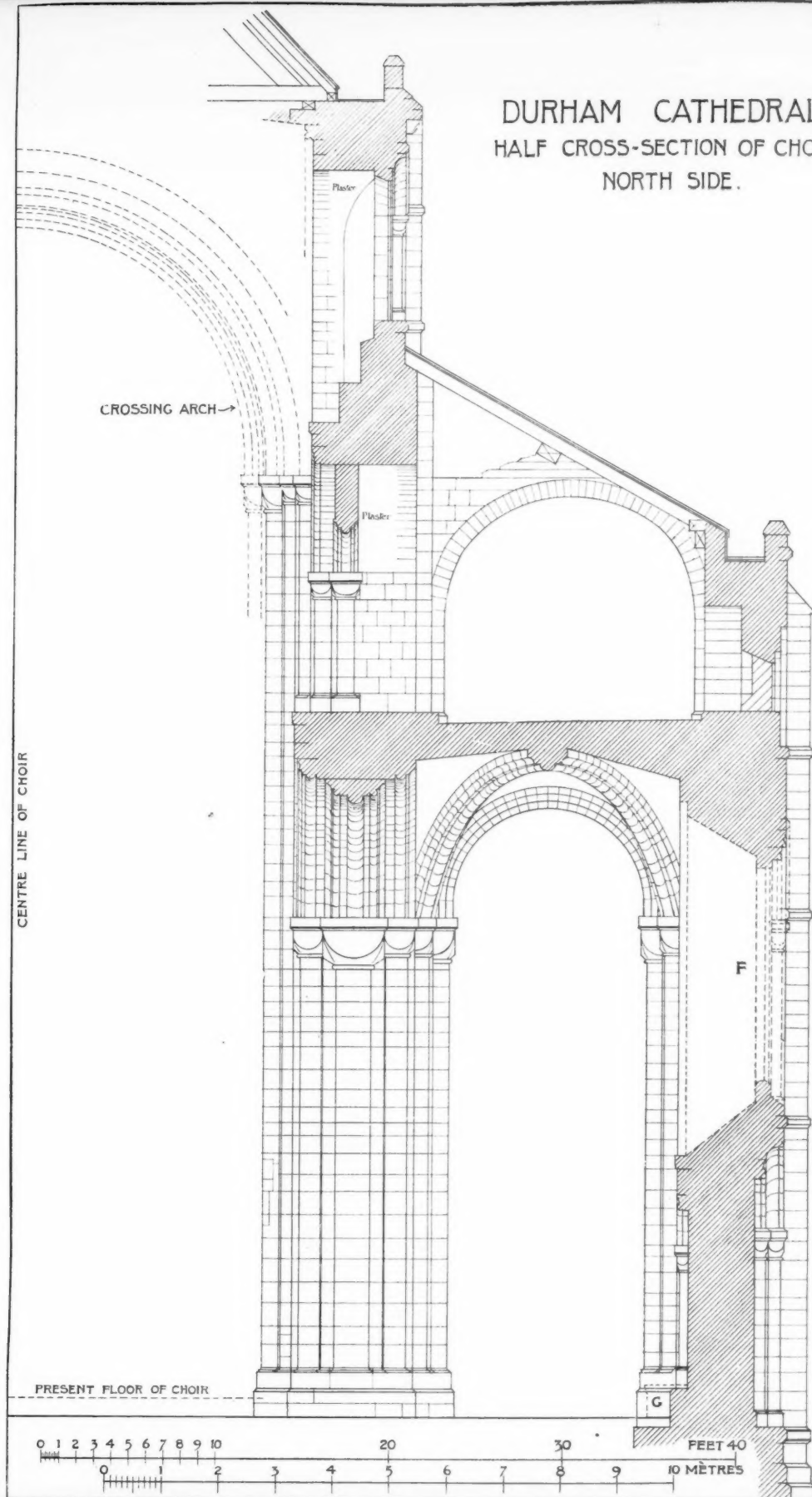
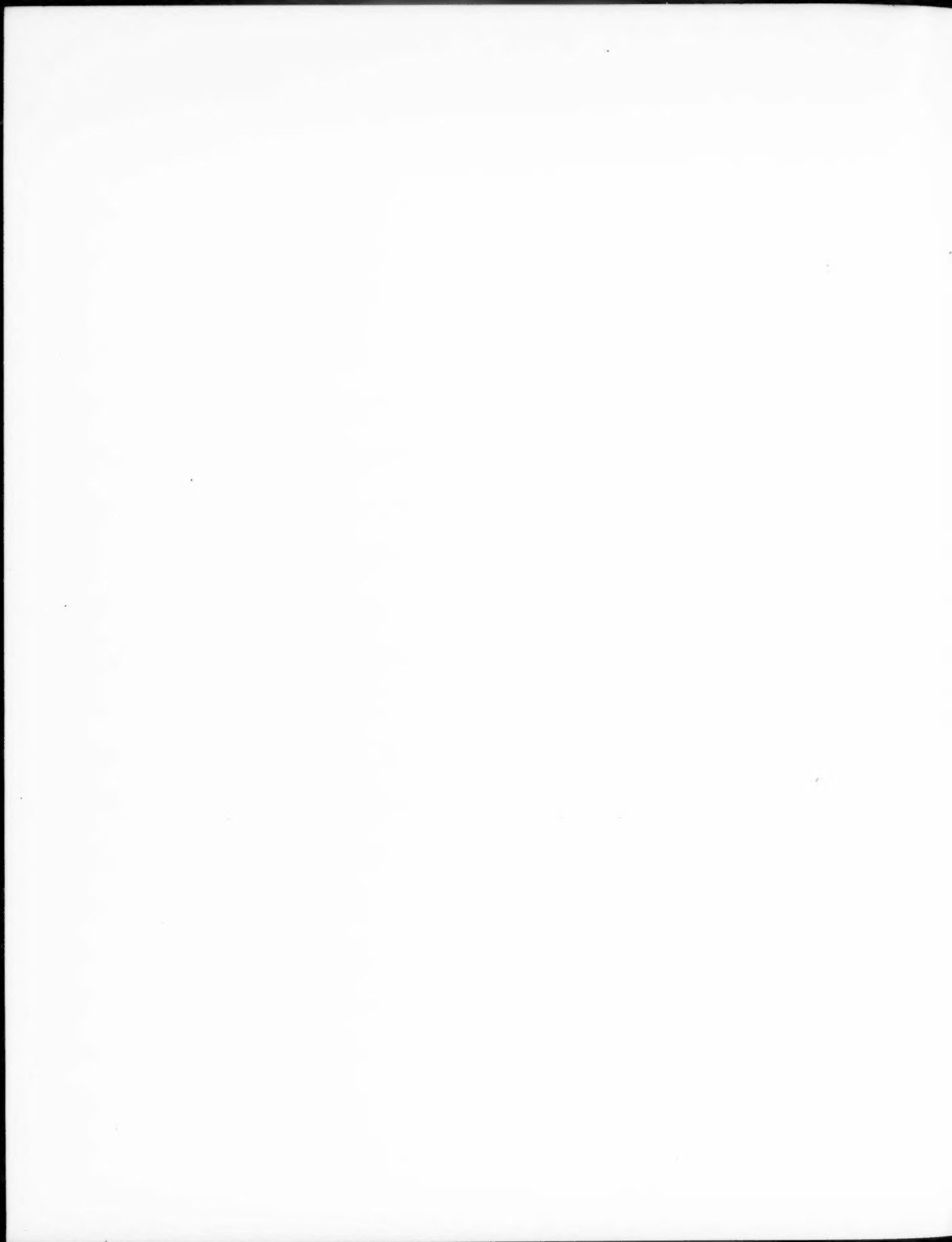


FIG. 8.

DURHAM CATHEDRAL,
HALF CROSS-SECTION OF CHOIR,
NORTH SIDE.





DURHAM
CATHEDRAL,
CHOIR.

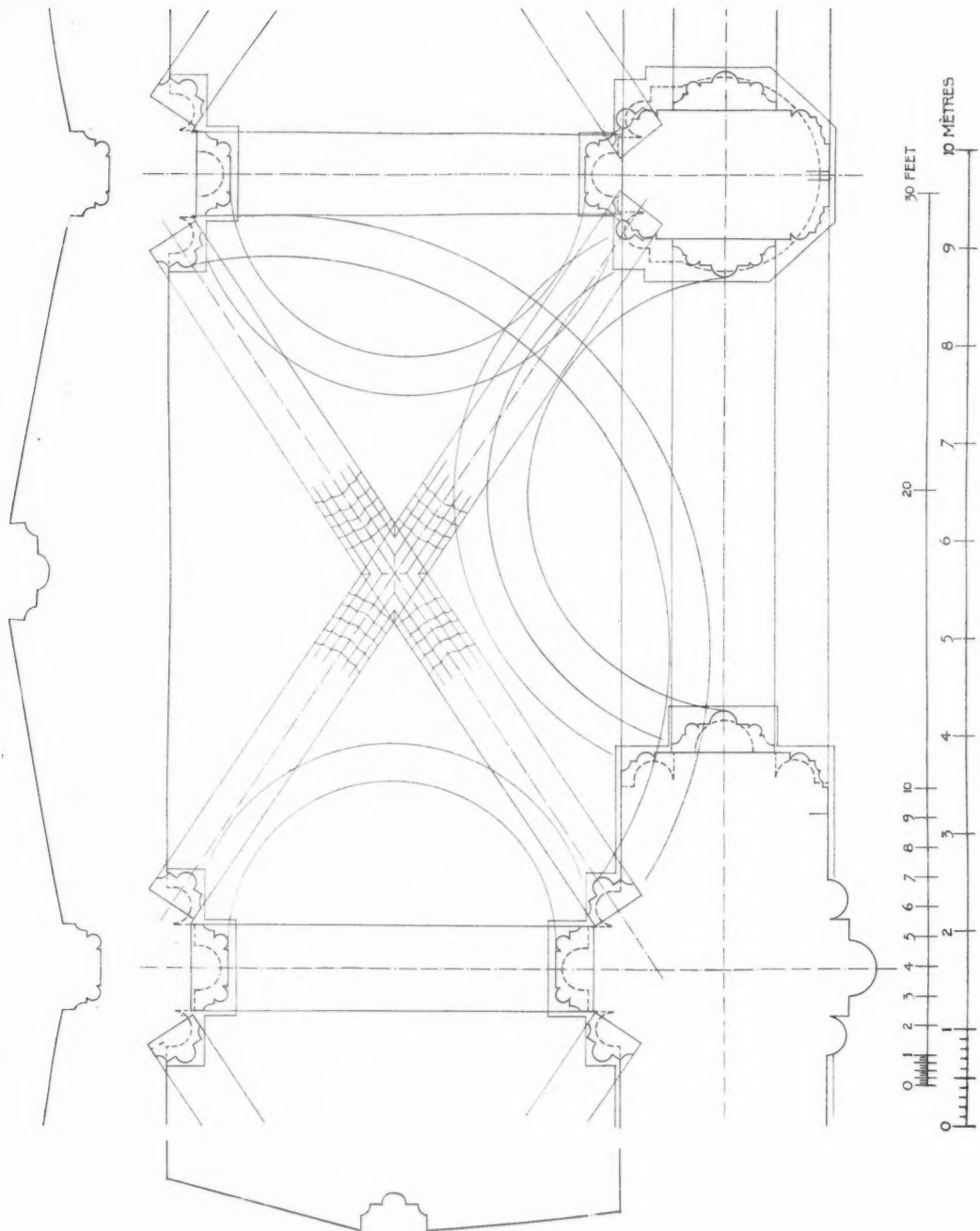
TRIFORIUM PLAN

GROUND

PLAN

Al Bilan
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oblong,* the length from east to west being much greater than the width from north to south. The span of the diagonal rib is consequently more than double the span of the transverse rib. The arcade arches are practically semicircular; that in the bay illustrated is struck from a centre about 8 inches below the springing line. The span of the transverse arch at the back of the minor pier is a little greater than the span of that at the back of the major pier; consequently, while the former is a semicircle, the latter is a semicircle stilted about 10 inches. The curves of the diagonal ribs are segments of circles, struck from centres about 4 feet 9 inches below the springing line, and the ribs consequently leave the capitals at a very abrupt angle. The keys of the diagonal ribs are placed considerably above the crowns of the transverse arches, and all the cells of the vault at the crown slope upwards towards the keys of the diagonal ribs.† The vault curves on the side walls are lower than semicircles, that on the aisle wall considerably lower. The vault curve on the main wall of the choir is not concentric with the arcade arch, owing to the great width of the major pier, which causes a spandrel of wall to be left between the arch and the vault on the side next the major pier. It is important to notice that, unlike the groin of an unribbed vault, the curve of the rib here is not determined by the intersection of the vaulting cells; on the contrary, the rib is set out independently, and its curve determines the curves of the cells.‡ This is shown in a marked manner in the cells next the side walls (aisle wall and choir wall), where the surface of the cell is twisted to a very considerable extent—a necessary consequence of the fact that the centre from which the diagonal rib is struck is at a much lower level than the centres of the vault curves on the side walls. The section of the transverse arch shows a roll and hollow on each edge; that of the diagonal rib is a large roll between two hollows. The mouldings of the diagonal ribs do not clear themselves well at the springing, especially on the minor piers of the main arcade (see figs. 10, 11, and 12). The ribs, like the arches generally, are constructed of thin stones, averaging about 7 inches in thickness. The keys of the diagonal ribs are jointed in a primitive fashion; the sides of the keys are not shouldered for the ribs, but the joints continue the lines of the sides of the ribs, and stones of nearly triangular shape are introduced next the key to bring the next joint square with the rib (fig. 10).§ The vaults have no wall-rib or wall-arch. The vaults of the transept aisles are exactly like those of the choir aisles, except that the plans of the bays are of different proportions. All these aisle vaults are clearly part of the original work; the masonry and mouldings correspond in character with those of the choir arcades, and, for constructional reasons, the aisle vaults must, as usual, have been erected along with the main walls. It has been suggested that the vaulting shafts may have been planned to receive the unribbed groins of vaults like those at Winchester and Ely, and that the actual vaults at Durham are reconstructions; but the structure of the vaults themselves does not afford the least ground for such a conclusion, which is moreover emphatically contradicted by the plan of the vaulting-shafts at the angle between the choir aisle and transept aisle, both on the north and south sides. In the choir aisle triple vaulting-shafts receive the three ribs of the vault, as elsewhere; in the transept aisle two shafts only were required, since the diagonal rib of the bay of junction was already provided for, and the plan of the wall-pier was modified accordingly by the omission of the

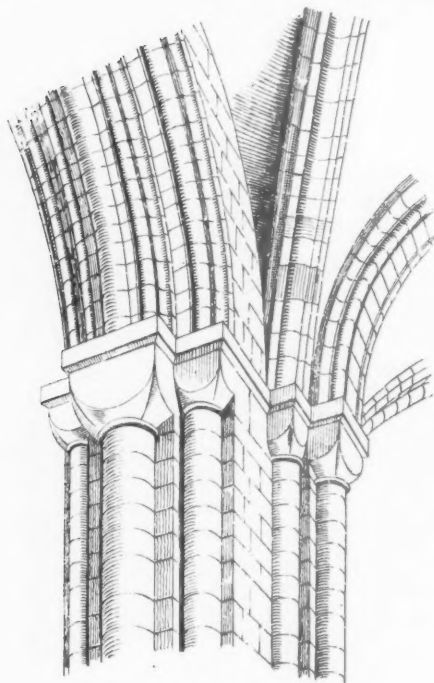
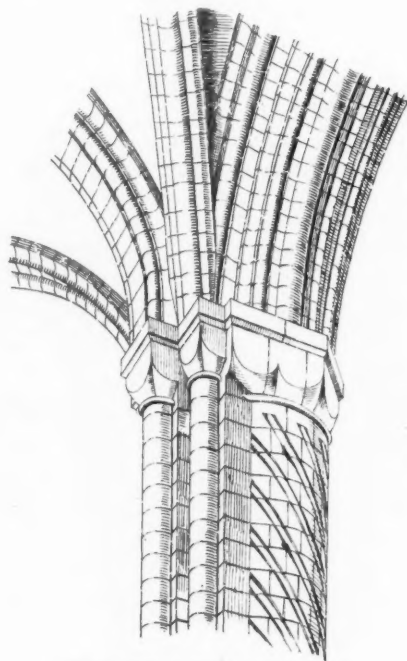
* Except the western bay, which is more nearly square, its width being governed by the width of the transept aisle. The other bays of the choir are set out nearly equally to the centres of the piers.

† The sections of the vault at the crown are shown in fig. 10. In the bay illustrated the surface of the vault cells at the keys of the diagonal ribs is about 8 inches above the crown of the vault on the choir wall (over the

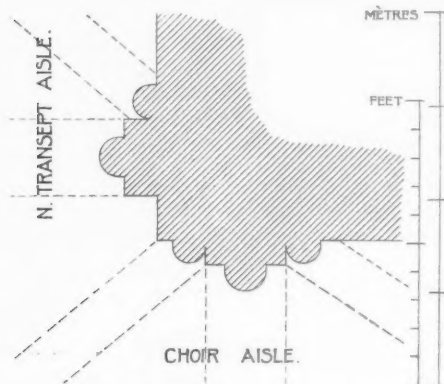
great arcade), 1 foot 9 inches above the crown of the vault on the aisle wall, and 2 feet 3 inches above the crown at the transverse arches.

‡ It is scarcely necessary to say that this fact alone proves that the ribs cannot possibly have been added under the groins of an unribbed vault.

§ The keys of the other Norman vaults in the cathedral are constructed in a somewhat similar manner.

FIG. 11.—DURHAM, NORTH AISLE OF CHOIR.
SPRINGING OF VAULT ON MAJOR PIER.FIG. 12.—DURHAM, NORTH AISLE OF CHOIR.
SPRINGING OF VAULT ON MINOR PIER.

unnecessary shaft (see fig. 13).^{*} If unribbed vaults were intended, the obvious plan would have been to spring the groin from the angle of the wall itself, and it is not likely that the builder would have gone out of his way to create a difficulty in order to overcome it.

FIG. 13.—DURHAM, PLAN OF PIER AT ANGLE OF CHOIR
AISLE AND TRANSEPT AISLE.

The vaults of the aisles of the nave of Durham are the work of bishop Ralph Flambard (1099–1128), and, as he completed the nave as far as the high vault, the aisle vaults may safely be attributed to the first twenty years of the twelfth century. They correspond in character with the aisle vaults of the choir and transepts, except in a few minor points. The supports on the back of the major piers and on the aisle wall opposite are triple shafts, as in the choir and transept aisles. The minor piers, however, are cylindrical, *without* any attached shafts to receive the ribs, and the corresponding piers on the aisle wall are half-cylinders. The spans of the transverse arches opposite the minor piers are consequently wider than those of

the arches opposite the major piers, and the curves of the former are modified accordingly. The transverse arches throughout are of the same section as those in the aisles of the choir

^{*} The same method was followed, at a much later date, at the angles of the choir and transept aisles of Lisieux Cathedral.

and transepts, as also are the diagonal ribs in the two easternmost bays. In the other bays the diagonal rib has a large roll with a chevron on each side, instead of a hollow. The vaults beneath the western towers, which are also Flambard's work, exhibit a variation which is worth notice. As the towers project considerably beyond the walls of the aisles, the diagonal ribs of the tower vaults have a greater span than those of the aisle vaults. The capitals

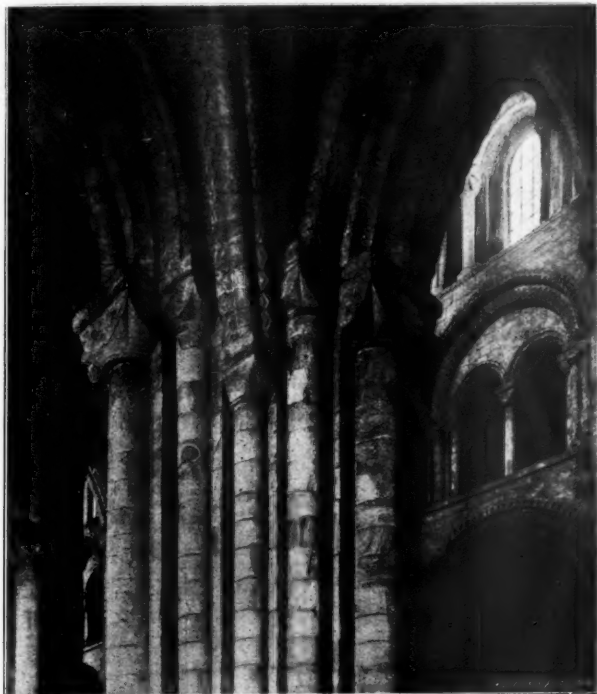


FIG. 14.—DURHAM, VAULT UNDER NORTH-WEST TOWER.

of the shafts which receive the diagonal ribs are therefore placed at a lower level than the capitals which receive the arches opening into the nave and aisle (fig. 14),* in order to give greater height to the diagonal rib by thus lowering its springing. The same expedient was adopted in Suger's work at Saint-Denis in the vaults beneath the western towers (1137–1140), where, however, the arches are all pointed.†

Our next dated example of ribbed vaulting is to be found in the reconstructed parts of the transepts of Winchester Cathedral. The original work in these transepts (noticed above) belongs to the church which bishop Walkelin commenced in 1079, and which the monks entered in 1093. The central tower fell in 1107,‡ and the works of reconstruction which were necessitated by this catastrophe can be readily distinguished from the original work by the different thickness of the joints of the masonry, which in Walkelin's work are very thick, whereas the reconstructed masonry is close-jointed.§ In the reconstructed bays of the transept aisles the vaults were entirely rebuilt as ribbed vaults, the diagonal ribs springing from the shafts which originally received the projecting groins of the unribbed vaults (fig. 2, vii., in which AA are the diagonal ribs of the reconstructed vault). As at Durham, the curve of the diagonal rib is a segment of a circle struck from a centre below the springing level. The crowns of the vaults are practically level. The section of the rib shows a large roll flanked by small hollows—a similar section to that used in the Durham aisle vaults, but more refined in detail.|| The ribs are of thin stones, and close-jointed. The keys are shouldered to receive the ribs, which abut against them with a joint at right angles to the direction of the rib. In the northernmost bay of the east aisle of the north transept, which would not be

* I am indebted to Mr. J. Freeman, verger of the Cathedral, for kindly taking this photograph specially for me. See also Billings' *Durham Cathedral*, pl. 42.

† *Die Kirchliche Baukunst des Abendlandes*, pl. 153, fig. 8.

‡ "Anno Mviii. Turris ecclesie ejusdem cecidit nonas

Octobris." *Annales Monasterii de Wintonia*, in *Annales Monastici* (Rolls Series, ed. H. R. Luard), ii. 43.

§ *The Architectural History of Winchester Cathedral*, by Professor Willis, *Archæol. Inst.*, Winchester vol., p. 25.

|| The diagonal ribs in the Durham aisle vaults are 22 inches wide, and those at Winchester 14 inches wide.

affected by the fall of the tower, the vault itself does not appear to have been rebuilt, but the ribs seem to have been added under the original vault, and are backed out up to the groins.* With regard to the date of these ribbed vaults, we cannot doubt that, in a church so important as Winchester, the monks would immediately undertake the repair of the damage

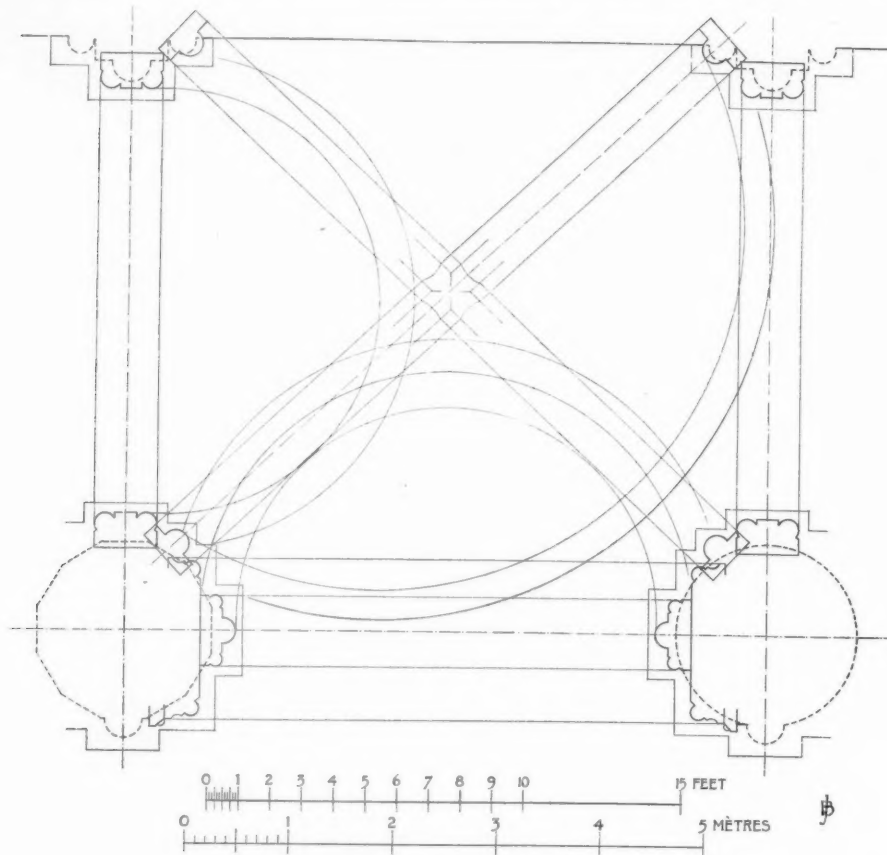


FIG. 15.—PETERBOROUGH, SOUTH AISLE OF CHOIR. PLAN OF VAULT.

caused by the fall of the tower, and we are justified in dating the vaults within two or three years from 1107, the year in which the tower fell.†

Peterborough Cathedral presents examples of ribbed vaults, the date of which is proved by documentary evidence. The earlier church was destroyed by fire in 1116, and the present building was commenced in 1117 or 1118.‡ In 1140 or 1143 (both dates are given by

* Professor Willis's statement (p. 25, *ut sup.*), as to the bays in the north transept aisles which have ribbed vaults, is not quite correct. The bays marked c and j on his plan (fig. 36) have ribbed vaults. In the bay n I think that the ribs have been added under the original vault. The bays d, e, f, and g have the original unribbed vaults. In the bay i the ribs are a fourteenth-century reconstruction.

† M. Félix de Verneilh (*Annales Archéologiques*, xxiv.

234) quotes Professor Willis to show that these vaults are of later date than the original structure, but he does not mention the date of the fall of the tower, which necessitated the reconstruction of the vaults in question—a date which certainly does not suit his conclusions.

‡ "An. Mxvi. In this same year all the minster of Burh was burnt." (*Anglo-Saxon Chronicle*, Rolls Series, ed. Benj. Thorpe, i. 371, ii. 213.)

"Mxvi. Tota ecclesia et villa combusta est. . . In

different chroniclers*) the monks entered the new church. The parts then completed include the choir and east side of the transepts (except, perhaps, the clerestories). The aisles of the choir and transepts throughout are covered with ribbed vaults (fig. 15). The transverse and diagonal ribs are supported by triple shafts on the aisle wall (fig. 17). The piers of the main arcades are circular and polygonal, and their capitals are subdivided so as to provide a separate corbel for each order of the arch and each rib of the aisle vault (fig. 16). Both the arcade arches and the transverse ribs of the aisle vaults are semicircles, slightly stilted. The diagonal ribs are segments of circles struck from centres below the springing line, the crowns of the vaults being practically level. The vault cells at the back of the diagonal ribs are considerably twisted at the springing, though not to the same extent as at Durham, as the plan of the bay here more nearly approaches a square. The transverse ribs

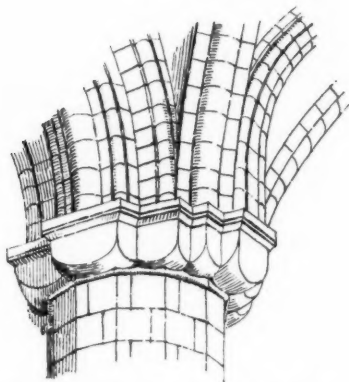


FIG. 16.—PETERBOROUGH, SOUTH AISLE OF CHOIR.

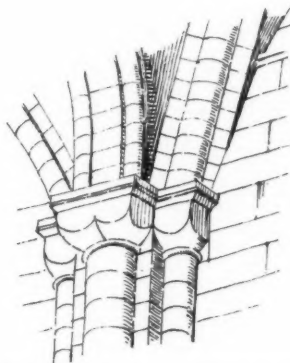


FIG. 17.—PETERBOROUGH, NORTH AISLE OF CHOIR.

have a roll on each edge, and the diagonal ribs a large roll flanked by a flat on each side.† These vaults have no wall-ribs.

It is necessary here to examine M. Félix de Verneilh's conclusions‡ with regard to these vaults, since they appear to be the authority for M. Lefèvre-Pontalis' statement that the ribs at Peterborough were added afterwards, in the second half of the twelfth century.§ M. de Verneilh, after noticing that the aisles of Romanesque churches in England are covered with unribbed groined vaults, asserts that, from motives of pure embellishment, ribs were introduced under the groins of primitive vaults, or these vaults were entirely rebuilt, without

alio autem anno ipse abbas inchoavit novam ecclesiam, et jactavit fundamentum octavo idus Martii, anno ab Incarnatione Domini millesimo centesimo decimo octavo, et multum operatus est in ea, sed non complevit." (*Hugonis Candidi Cenobii Burgensis Historia*, p. 72, printed in Sparke's *Historia Anglicana*.)

"Mxvi. Monasterium Burgi, cum magna parte villæ adjacentis, combustum est secundo nonas Augusti, die Veneris." "Mxvii. Fundamentum novæ ecclesiæ Burgi ponitur quarto idus Martii." (*Chronicon Angliæ per Johannem Abbatem Burgi S. Petri*, p. 64, in Sparke's *Historia Anglicana*.)

* "Martin, abbot, . . . brought them [the monks] into the new minster on St. Peter's mass-day, with great worship. That was anno ab incarnatione Dom. Mxcl, a combustione loci xxlii." (*Anglo-Saxon Chronicle*, i. 383, ii. 232.)

"Mxcl. Martinus autem abbas sub isto rege . . . multa operatus est, et presbyterium ecclesiæ perfecit . . . monachos in die festivitatis Sancti Petri in novam ecclesiam cum magno gaudio introduxit." (Hugo Candidus, p. 76.) Martin was abbot from 1133 to 1155.

"Mxliii. Conventus Burgi hoc anno intravit in novam ecclesiam." (*Chron. per Johannem*, p. 75.)

"Mxliii. Conventus Burgi intravit novam ecclesiam." (*Chronicon Petroburgense*, Camden Soc., ed. Thomas Stapleton, p. 2.)

† The gateway to the west of the church has a very similar vault.

‡ *Le Style ogival en Angleterre et en Normandie*, by Félix de Verneilh, *Annales Archéologiques*, 1864, xxiv. 232 et seq.

§ E. Lefèvre-Pontalis, *op. cit.* i. 89.

any change being made in the form or direction of their supports; thus the capitals and bases of the shafts which receive the springings of the ribs, instead of facing in the direction of the rib, present their angles in that direction. He seems to have been led to doubt the authenticity of the earliest ribbed vaults in England (including these at Peterborough) by the fact that the capitals under the diagonal ribs are usually set square instead of being set diagonally in the direction of the rib, as is generally the case in the Ile-de-France. He asserts that the latter method is constant in France, with very rare exceptions—such as one of the bays in Suger's narthex at Saint-Denis. These exceptions, however, are by no means so *infiniment rares* as M. de Verneilh suggests, for the capitals under diagonal ribs are set square, not anglewise, in several of the most important early examples in the Ile-de-France.* After examining the Peterborough vaults M. de Verneilh came to the conclusion that the supporting shafts were designed to receive the projecting groins of unribbed vaults, and that the actual ribs were added afterwards, because he thought he found that the arcade arches were continued down to the caps behind the springing of the diagonal ribs. What is actually

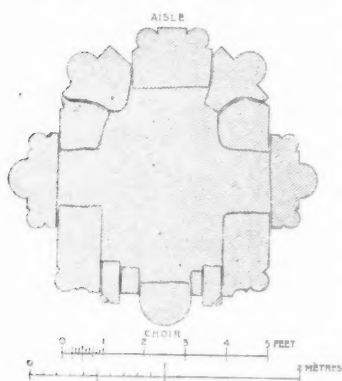


FIG. 18.—PETERBOROUGH, NORTH SIDE OF CHOIR. PLAN AT SPRINGING OF AISLE VAULT.

done is that the diagonal ribs at their springing are fitted between the arcade arches and transverse ribs, as shown in fig. 18;† the back of the rib is not thinned off in the manner shown in M. de Verneilh's drawing. But in all these early ribbed vaults the ribs and arches are fitted together in this crude fashion,‡ and this fact is rather an argument *for* than *against* the date assigned to them, for we can only expect such crudities in first attempts. Since M. de Verneilh wrote, however, the central tower of Peterborough has been taken down and rebuilt, and an opportunity has consequently been afforded for ascertaining exactly how the aisle vaults were constructed. Mr. J. T. Irvine, the experienced clerk of works who superintended the work, assures me that no evidence whatever was found to support M. de Verneilh's theory. Apart, indeed, from the evidence of the structure itself the theory is untenable.

The ribs cannot have been added under the groins of earlier unribbed vaults, for a simple geometrical reason. The groin of an unribbed vault is a semi-ellipse, but the actual curve of the rib is a segment of a circle. If the ribs had been added they must have been backed out to the elliptical curve of the groins; § but such is not the case. If, therefore, the ribs are later than their supports the vaults themselves must have been reconstructed. It is, however, too much to ask us to believe that all the original vaults of the choir aisles and transept aisles (fourteen bays in all) were removed within half a century from their construction without leaving any trace of their existence and without any sign in the structure itself of any failure or catastrophe such as might have necessitated their removal. That these Peterborough vaults are original is clear, too, from the fact that they do not stand

* The capitals under diagonal ribs are set square in the following French examples:—Morienvall (ambulatory), Saint-Denis (south-west tower and ambulatory), Sens Cathedral (choir aisles and nave aisles), Saint-Martin, Laon (choir), Noyon Cathedral (south transept and nave aisles, in part), Saint-Maclou, Pontoise (ambulatory), Saint-Germain des Prés, Paris (choir and ambulatory), Saint-Leu d'Esserent (ambulatory), Soissons Cathedral (south transept aisle).

† I am indebted to Mr. J. T. Irvine for this drawing. Viollet-le-Duc's drawing (*Dictionnaire*, iv. 102, fig. 54 *ter*) shows the rib and arcade arch as dying into one another in a single springer stone, which (as M. de Verneilh points out) is

quite inaccurate. It was not until towards the end of the twelfth century that solid springers were introduced. Yet Viollet-le-Duc's drawing was reproduced without correction in an essay which recently obtained the R.I.B.A. Essay Prize.

‡ Cf. Lefèvre-Pontalis (*op. cit.* ii. 6) on the choir vault at Bellefontaine, where the ribs "viennent retomber maladroitement sur quatre colonnettes." The same awkward fitting is to be seen in the choir aisles (over the piers) of Laon Cathedral.

§ This is the case in the north-east bay of the north transept at Winchester.

alone, but are analogous in their method and construction to a large number of vaults which cannot all be the result of such an alteration as M. de Verneilh suggested.

Let us now pass to the consideration of examples of similar ribbed vaults, as to the date of which we have no documentary evidence, and to which only approximate dates can be assigned from the character of the work. One of the earliest of these examples is the vaulting over the north aisle of the nave of Gloucester Cathedral (fig. 19). The rebuilding of the abbey church was commenced by abbot Serlo in 1089, and the church was dedicated in 1100. Probably only the eastern part of the church was then completed, but we may safely assign the north aisle, with its vaulting, to the first twenty years of the twelfth century. The vaulting shafts on the aisle wall form groups of five; a semi-cylindrical attached shaft receives the transverse arch, which is semi-circular, and of simple square section; the two shafts on each side, which receive the diagonal ribs and wall-arches, are of the quarter-round section which we find in the earlier work in the choir. The diagonal ribs are segments of circles struck from centres below the springing line; their section shows two rolls separated by an angular fillet. The wall-arches are considerably stilted. The bays of the vault are nearly square. In some bays of the ambulatory of the crypt (the original vaults of which are unribbed) the piers have been eased, and the vaults have been strengthened by the addition of diagonal ribs, some of which are square in section, while others show a large roll flanked by small hollows. The alterations seem to be contemporary with the north aisle of the nave. In the little church of Avening (Gloucestershire)* we find ribbed vaults, of c. 1120-1130, which seem to have been inspired from the early twelfth-century work at Gloucester. In the western bay of the chancel the diagonal ribs have a large roll flanked by small hollows, while those under the tower are of simple square section. In both these vaults the diagonal ribs spring from angle shafts, the capitals of which are set anglewise, in the direction of the rib.

The aisles of the nave of Southwell Minster are covered with ribbed vaults of c. 1120.† The transverse ribs are semicircles considerably stilted. The diagonal ribs are segments of circles struck from centres below the springing line, and, as the plan of the bay is a pronounced oblong, these ribs have a low sweep, and the vault cells at the back of them are considerably twisted at the springing. The ribs, both transverse and diagonal, have a roll on each edge separated by two angular fillets. There is no wall-rib.‡

The priory church of Lindisfarne was built by Edward, who probably died near the end of Ralph Flambard's episcopate (1128).§ Reginald of Durham, who wrote c. 1165, tells us

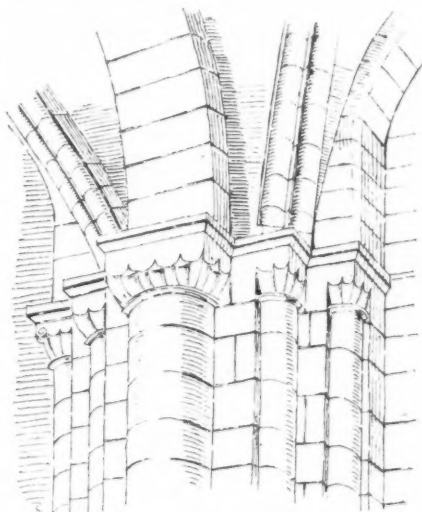


FIG. 19.—GLOUCESTER, NORTH AISLE OF NAVE.

* A paper on this church, illustrated by plans, by R. Herbert Carpenter and B. Ingelow, is printed in the *Transactions of the Bristol and Gloucestershire Archaeological Society*, xiv. 5-13.

† M. Lefèvre-Pontalis (*op. cit.* i. 89) says that these vaults are not earlier than the end of the reign of Henry I., but he gives no reason for this opinion. The only documentary evidence available is a letter of arch-

bishop Thomas (no doubt Thomas II., 1109-1114) asking for contributions towards the erection of the church. The character of this part of the nave indicates a date of c. 1120 as most probable.

‡ For plan of Southwell Minster see *The Builder*, lxi. 12; detail of springing of vault over main piers on p. 15.

§ *History and Antiquities of North Durham*, by Jas.

that Edward erected in honour of St. Cuthbert a church new from its foundations, which he finished (*consummavit*) of squared stone, with all elegance of workmanship.* The church throughout was covered with ribbed vaults, and its design is an evident inspiration from Durham. The vaults of the main spans will be described presently. The piers of the nave arcades are alternately cylindrical and clustered; the ribs of the vaults of the north aisle (the vaults of the south aisle no longer exist) are supported by triple shafts alternating with attached semi-cylindrical shafts (as in the nave aisles of Durham), but the capitals of the latter shafts are subdivided to receive the three ribs—an advance on Durham, where the capitals of the corresponding shafts are semi-octagonal. The transverse ribs of the aisle vaults are semicircles stilted about two courses in height. The diagonal ribs were segments

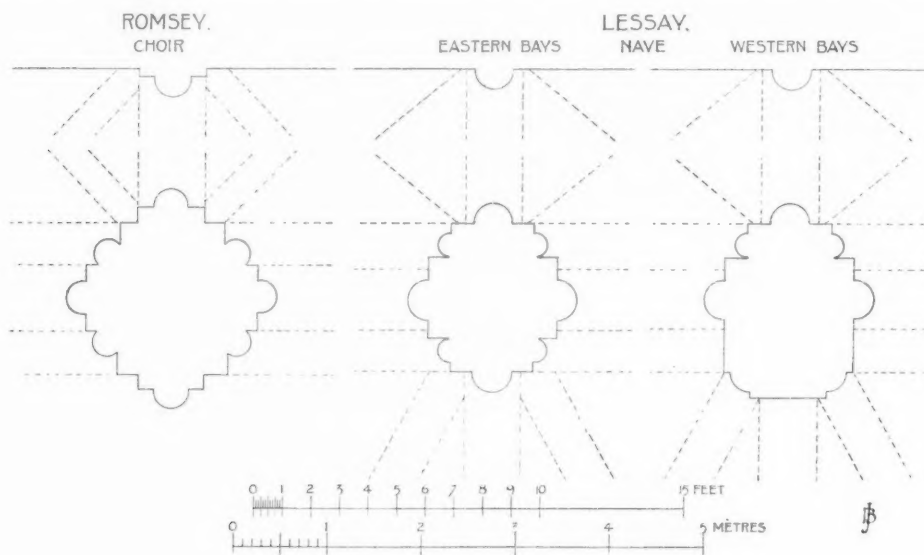


FIG. 20.—PLANS OF PIERS.

of circles struck from below the springing. The transverse ribs have a roll on each edge, and the diagonal ribs a roll between two hollows. There is no wall-rib.†

The nave of the abbey church of Dunfermline is another work which was clearly inspired by Durham. It was probably erected soon after the accession of David I. in 1124.‡ The ribbed vaults over the aisles correspond almost exactly in detail with those of the aisles at Lindisfarne. The eastern bays of the nave of Selby abbey church also afford marked indications of Durham influence.§ The piers of the nave arcades are alternately clustered and cylindrical, the latter having attached shafts at the back to receive the ribs of the aisle vault, which recall the arrangement in the choir of Durham, although the work here is of more advanced character. The original ribbed vaults remain over the two eastern bays of

Raine, p. 74. The evidence as to the date of Edward's death is not very conclusive. In the list of Durham monks his name immediately follows that of Symeon, the historian, who probably died shortly after 1130.

* *Reginaldi Monachi Dunelmensis Libellus*, &c., ed. Jas. Raine, Surtees Soc., vol. i. pp. 44, 45.

† For plan and description of the church see *The*

Builder, lxxviii. 414. The internal view shows the vaulting of the north aisle.

‡ *The Ecclesiastical Architecture of Scotland*, by David Macgibbon and Thomas Ross, i. 231, &c. The aisle vaults are illustrated in figs. 208, 210, and 212.

§ *The Architectural History of Selby Abbey* (with plan by C. C. Hodges, *Yorkshire Archaeological Journal*, xii. 344

the south aisle. The support of the transverse rib at the back of the easternmost pier is a square pilaster, with two shafts separated by an angle fillet on its face. The semicircular transverse rib shows a similar section. The diagonal ribs, of segmental curve, have a large roll flanked by a flat on each side, and are supported by shafts on each side of the projection described above.*

The vaults of the choir aisles of Romsey abbey church are similar in their system to those already described. The supporting piers, however, were evidently designed for unribbed groined vaults; their plan shows a projecting pilaster with a single shaft on the face (fig. 20), the normal method of supporting the transverse arch of an unribbed vault. There is, therefore, no preparation for receiving the diagonal rib, which actually springs from a little corbel placed across the angle upon the abacus (fig. 21). Further west, in the later work, triple shafts are in some cases provided to receive the three ribs in the usual way.† At Lessay, in Normandy, the existing ribbed vaults over the choir, transepts, and eastern bays of the nave spring awkwardly from single shafts, which were clearly designed for unribbed vaults, such as were actually constructed in the aisles. In the western bays of the nave the plan of the pier was modified, by substituting for the single shaft a projecting pilaster with a quarter-round shaft on each edge (fig. 20), which afforded a more fitting support for the three ribs of the high vault. These examples are interesting as showing how the idea of the ribbed vault was introduced, during the course of construction, in works which were originally planned only for unribbed vaults.

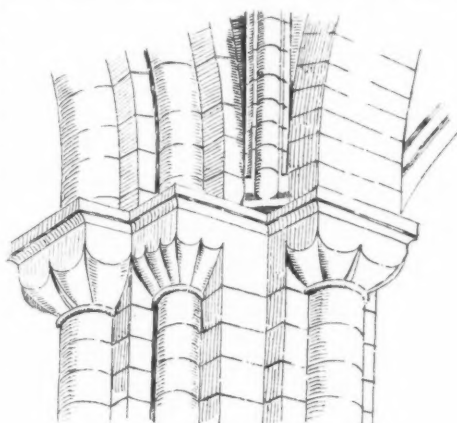


FIG. 21.—ROMSEY, SOUTH AISLE OF CHOIR.

The two churches at Devizes (Wiltshire) afford examples of aisleless chancels covered with ribbed vaults. These works may with some probability be attributed to the architectural influence of bishop Roger of Salisbury, and may be dated approximately at c. 1125–1130, St. John's being slightly earlier than St. Mary's. In each church the chancel is divided into two oblong bays. The transverse arch between the two bays is supported by coupled shafts, flanked by shafts which receive the diagonal ribs, with corresponding shafts in the angles of the east end. In St. John's church (fig. 22) the semicircular transverse arch is of square section, un moulded, and the diagonal ribs have a large roll with a small hollow on each side. In St. Mary's church the transverse arch is moulded with two large rolls separated by a small angular fillet, and flanked by a small hollow and fillet; the diagonal ribs show a large roll with a small hollow and fillet on each side. The ribs are in narrow stones, and the keys are shouldered, as shown in fig. 22. There are no wall-ribs, and the lateral cells of the vaults show upright semi-elliptical curves on the side walls. In each case the crown of the vault at the key of the diagonal rib is a little higher than at the crown of the transverse arch—

* It is scarcely necessary to point out how far these examples confirm what has been said above in contradiction of the theory that the Durham vaults are reconstructions.

† Even in the eastern part of the church, however, the method is not quite constant, for shafts are provided to receive the diagonal ribs at the western angles of the ambulatory across the east end of the choir itself, and

also at the western angles of the choir aisles, next the transepts. In these vaults the transverse arches are of square un moulded section, and the diagonal ribs show a roll between two small hollows (as at Winchester). No documentary evidence seems to be available as to the date of Romsey, but from the character of the work its commencement may be assigned to c. 1110. For plan and description of the church, see *The Builder*, lxi. 236.

one foot higher in St. John's church and five inches higher in St. Mary's church. We find here a tendency to improve the curve of the diagonal rib. In all the English ribbed vaults which have been noticed above, the curve described by the diagonal rib appears to be a segment of a circle, the centre of which is placed below the springing line. This curve is unsatisfactory in appearance, since the rib springs from the wall or pier at an awkward angle, and it is also objectionable as a matter of construction, because the lateral thrust of the rib

is unnecessarily increased. Consequently we find in some later examples that, while the transverse arches still remain semicircular, the diagonal ribs describe a semi-elliptical curve.* In the chancel of St. John's, Devizes, the curve of the diagonal rib is only slightly quicker than a segment of a circle, but at St. Mary's the curve more nearly approaches a true semi-ellipse.† The vaulting of the south aisle of Dunstable priory church is a somewhat later example of the use of a semi-elliptical curve for the diagonal rib.

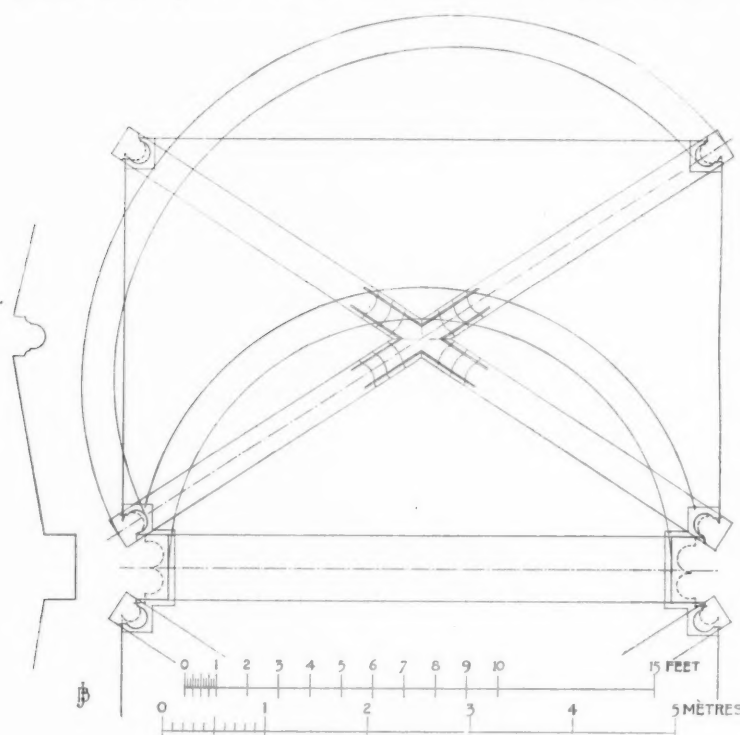


FIG. 22.—ST. JOHN'S CHURCH, DEVIZES, CHANCEL. PLAN OF VAULT.

The difficulties which confronted the builders of these early ribbed vaults, so long as they employed only semicircular or semi-elliptical curves for the ribs, were entirely surmounted by the adoption of the pointed arch for the arcade arches and transverse ribs, for it then became possible to make the diagonal ribs semicircular without raising their keys to any considerable extent above those of the transverse ribs. The nave aisles of Malmesbury abbey church have been frequently quoted as the earliest example in England of this new method of construction,‡ and have been attributed to bishop Roger of Salisbury. Although the excellent character of the masonry strikingly illustrates William of Malmesbury's description of bishop Roger's work, it is scarcely probable that the rebuilding of the church was commenced before the

* The vaults of the Caen group exhibit various experiments in the curves of their ribs (stilted semicircles, segments of circles, and semi-ellipses).

† The central tower of St. John's, Devizes, affords an early example of the adoption of the pointed arch apart from any connection with vaulting. The tower is much

wider from north to south than from east to west; the east and west arches of the crossing are semicircular, while the narrower north and south arches are pointed.

‡ For plan of Malmesbury see *The Builder*, lxxviii. 164. The nave is illustrated in detail in *Vetusta Monumenta*, v., plates 1-9.

bishop's death in 1139; it must, however, have closely followed that event, and the existing nave cannot be assigned to a later date than the middle of the twelfth century.* The aisle vaults (fig. 23) are supported on the one side by the great cylindrical piers of the main

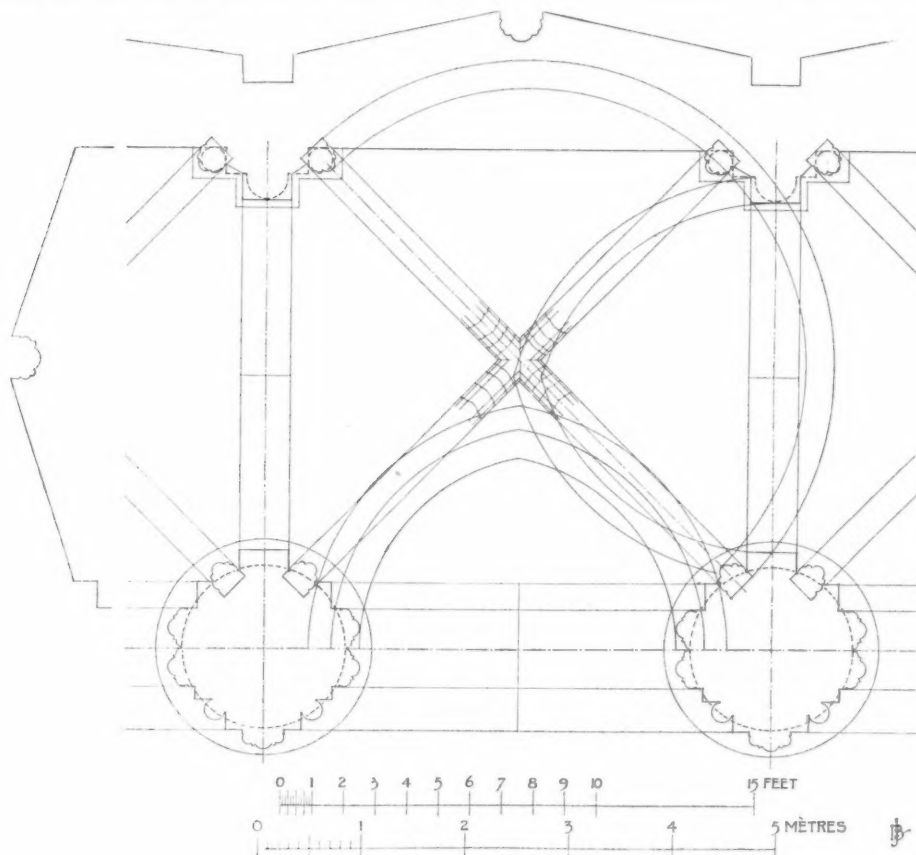


FIG. 23.—MALMESBURY, SOUTH AISLE OF NAVE. PLAN OF VAULT.

arcades, and on the other by triple shafts on the aisle wall. The arches of the main arcades and the transverse arches of the aisle vaults are all pointed,† the latter being of square unmoulded section. The diagonal ribs are semicircular, and their section shows three large

* The passage which refers to bishop Roger's works reads thus:—"Pontifex magnanimus, et nullis unquam parcens sumptibus, dum que facienda proponeret, ædificia præsertim, consummaret: quod cum alias, tum maxime in Salesberia et Malmesberia est videre. Fecit enim ibi ædificia spatio diffusa, numero pecuniarum sumptuosa, specie formosissima; ita juxta composito ordine lapidum, ut junctura perstringat intuitum, et totam maceriam unum mentiatur esse saxum. Ecclesiam Salesberiensem et novam fecit et ornamentis excoluit, ut nulli in Anglia cedat, sed multas præcedat; ipseque non falso possit dicere Deo, 'Domine dilexi decorem domus tuæ.'" *Willelmi Malmesbiriensis Monachi De Gestis Regum Anglorum*, lib. v. § 408; Rolls Series, ed. Wm. Stubbs,

ii. 484. (See also *Historia Novella*, lib. ii. § 481, p. 558, in same vol.) The words 'et Malmesberia' in the passage quoted above are omitted in several of the texts, and if they are authentic they probably refer to the castle which bishop Roger built at Malmesbury, rather than to the church. William of Malmesbury, in his *Historia Novella* (which ends in 1142), makes no mention of any building work in the church, although he relates how the monastery regained its independence in 1140. It is probable that the rebuilding of the church was undertaken very soon after this event.

† It should be noted that at Malmesbury the pointed arch is only used in connection with the aisle vaults; the semicircular form is still retained for all other arches.

rolls with two smaller rolls between them. The keys of the diagonal ribs are placed higher than those of the arcade arches and transverse ribs; in the bay illustrated the surface of the vault cells at the key of the diagonal rib is 1 foot 5 inches above the surface at the apex of the transverse arches, and 2 feet above the surface at the apex of the arcade arches and the apex of the vault on the aisle wall. Mr. C. H. Moore* says that this vaulting is an imitation of French work, but this is mere assertion, and there is no evidence whatever to support it, unless we are to assume that the pointed arch necessarily came to England from the Ile-de-France.† The raising of the keys of the diagonal ribs above those of the transverse ribs, which he seems to consider a specially French characteristic, is found in many earlier ribbed vaults in England, and is sufficiently marked in the earliest of them all—those of the choir aisles of Durham.‡ In point of style Malmesbury is purely Anglo-Norman, and shows no trace whatever of the influence of such French work as the chapel of Bellefontaine and Saint-Denis. At the same time these aisle vaults at Malmesbury bring us to the threshold of the complete Gothic vaulting-system, and almost to the time when French influence does undoubtedly begin to

affect English work to some extent. We may now leave this part of our subject and turn to a consideration of the vaults over the principal spans of churches.

I have already said that the Normans aimed at nothing less than covering all parts of their churches with stone vaults. That the vaulting of the principal spans was intended to follow the vaulting of the aisles is sufficiently indicated by the plans of the piers. The choir piers of Saint-Nicolas, Caen, and Saint-Georges-de-Boscherville (fig. 24) may be taken as typical examples.§ Each shows a group

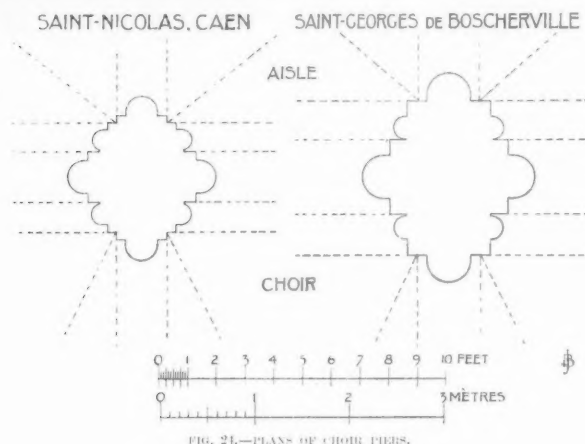


FIG. 24.—PLANS OF CHOIR PIERS.

of three shafts on each side of the pier to carry the arch-orders of the main arcades, a single shaft which receives the transverse arch of the unribbed aisle vault, and a corresponding shaft towards the main span. Bearing in mind the strictly logical relation between arches and vaults and their supports which is so characteristic of the Normans, the shaft which is generally found on the side of the pier next the principal span can have no other motive than to support a vault.¶ There can be no question about this in the two examples quoted,

* *Development and Character of Gothic Architecture*, by C. H. Moore (1890), pp. 124–127. Mr. Moore apparently accepts the date usually attributed to Malmesbury, as he speaks of it as a building nearly contemporaneous with Saint-Denis. He makes the surprising statement that Malmesbury is an isolated example, and that nothing in the island leads up to it—an error which, I venture to think, I have already sufficiently corrected. His drawing of the aisle vault (fig. 68, p. 124) is not correct in some details, and the diagonal ribs are not so shallow as he represents. Mr. Moore instances the nave aisles of Fountains abbey as a typical example of English vaulting of the middle of the twelfth century; as a matter of fact the system (pointed barrel vaults on transverse arches) is not English at all, but a Cistercian importation from Bur-

gundy (cf. Fontenay in Viollet-le-Duc, *Dictionnaire*, i. 179, fig. 14).

† The pointed arch appears in the nave vault of Durham, which (as we shall see) is an exactly dated example, earlier than the date here attributed to Malmesbury. The treatment of the pointed arch at Malmesbury is, however, much more systematic than at Durham.

‡ In the choir aisles of Durham the vault surface rises from the crowns of the transverse arches to the diagonal keys at almost exactly the same slope as at Malmesbury, though in the latter the slope from the arcades and aisle walls is steeper.

§ Cf. Lessay nave, fig. 20.

¶ The shaft next the principal span does not exist in such early examples as the Basse-Œuvre, Beauvais, or the

for the original unribbed vault remains over each of these choirs, and other examples have survived in Normandy in the choirs of Notre-Dame-sur-l'Eau, Domfront, and Sainte-Trinité, Caen.* It is quite true that in the majority of English examples this shaft does not actually receive a vault, but is merely carried up to the top of the wall, and sometimes finishes under the wood ceiling in a very inconsequential fashion. Nevertheless the motive of this shaft certainly cannot have been the support of a mere tie-beam, as is frequently asserted; it can only be explained by crediting the builders with the intention to vault the main span, though in most cases apparently they did not venture to carry out this intention. The half-barrel vault which still exists over the choir triforium of Gloucester Cathedral† must have been designed to afford the necessary abutment to a vault over the choir itself, though we have now no means of knowing whether such a vault was actually constructed. Surviving examples show that the choir was frequently vaulted, while the nave and transept were covered with wood ceilings, and unfortunately the choir is the part which has most generally been remodelled at a later date. It is not improbable that the failure which naturally attended the construction of the earliest vaults over wide spans may in some cases have rendered subsequent reconstruction a necessity. Whether it is due to this reason, or to the fact that the tradition of a wood ceiling was always strong in England, it is certainly true that very few early examples of vaults over wide spans have survived. Those which do remain are all the more valuable, and it is not unlikely that more careful investigation may add to our present knowledge in this respect.

> The earliest instance in England of a ribbed vault over the principal span of a great church, of which sufficient evidence has survived, is (so far as I know) the choir vault of Durham Cathedral, though here the original vault was replaced by the existing vault in the thirteenth century. The vault over the north transept of Durham is probably the earliest of such vaults still existing. The evidence of the structure itself, the analogy of the other vaults of this remarkable church, and the documentary evidence, taken together, enable us to speak with some approach to certainty of the character and date of the original choir vault of Durham. I have already stated that the choir was so far completed in 1104 as to permit the translation of the body of St. Cuthbert to the shrine at the east end. William of Malmesbury relates a wonderful story in connection with this translation—how St. Cuthbert himself in the night removed the centering which supported the vault above the shrine‡—which indicates that the vault over at least the eastern part of the choir had then been constructed—probably the whole choir vault, as there is little doubt that the whole work was of one date. Indulgences of the second quarter of the thirteenth century prove that this vault was then threatening ruin—one of them expressly describes it as a *stone vault*§—and it was subsequently taken down and replaced by the existing vault.

The plan of the choir of Durham (excluding the destroyed apse which formed its eastern termination) consists of two double bays, a type of plan which, at a later date, we are accus-

nave of Bernay, where a wood ceiling only was contemplated. Nor is it to be found in the following churches in the Soissonnais illustrated in M. Lefèvre-Pontalis' work, and attributed by him to the end of the eleventh century: Berneuil-sur-Aisne, Montlevon, Jouaignes, Oulchy-le-Château, and Saint-Léger-aux-Bois. Indications of such a shaft remain in the nave of Morienval (middle of the eleventh century), and M. Lefèvre-Pontalis suggests that this perhaps indicates an intention to cover the nave with a vault which they did not venture to construct (*op. cit.* i. 196).

* The choir of Saint-Georges-de-Boscherville is probably of the early years of the twelfth century, and the other three examples probably date within the eleventh century. Ruprich-Robert assigns Notre-Dame-sur-l'Eau,

Domfront, to c. 1050.

† Cf. the half-barrel vault over the nave triforium of Saint-Etienne, Caen. The springing of a similar vault still exists in the choir triforium of Cerisy-la-Forêt.

‡ "Materia lignorum, quæ recentem presbyterii testudinem sustinebat." *De Gestis Pontificum*, lib. iii. § 135; Rolls Series, ed. Hamilton, p. 276.

§ "Ubi supra sacrum illius sepulchrum devocio veterum lapideas erexit testudines, quæ jam nunc plenæ fissuris et ruinis dissolutionem sui indicant imminere." Indulgence of Hugh of Northwold, bishop of Ely, dated 1235; Durham Treasury, Misc. Chart. No. 1512 (printed in Raine's *Saint Cuthbert*, appendix, p. 7; see also pp. 101-3 for other indulgences).

tomed to associate with a sexpartite vault. There can, however, be no question of a sexpartite vault here, for the date is much too early for this kind of vaulting. It is worth notice, too, that the double bay does not form a square, but a pronounced oblong, the length of the double bay being much greater than the width of the choir itself.* Had there been any question of covering the double bay with a single quadripartite or sexpartite vault, the oblong plan of the bay would have involved the very difficulty which the double bay of square plan was designed to avoid. On the face of the broad major piers, triple shafts rise from the floor to the springing of the vault, and originally received a broad transverse arch, as in the transepts. The minor piers are cylindrical, with triple attached shafts at the back to receive the ribs of the aisle vaults. The wall-face of the triforium is set back 11 inches behind the wall-face below, and on this set-off stand the shafts which originally received the ribs of the vault—single shafts next the major piers, and triple shafts in the centre of each bay over the minor piers. Next to the major piers in each case the line of the original vault is distinctly marked by the junction of the original masonry of the clerestory with the masonry added in the thirteenth century when the existing vault was built (at BB and CC, fig. 7). Enough remains to indicate that the junction of the vault with the clerestory wall formed a tall semi-ellipse, as in the transept vaults. There can be no doubt that the original choir vault was a ribbed vault, for we cannot imagine that the builders who had already constructed ribbed vaults over the choir aisles would return to the unribbed vault for covering the main span. We may safely conclude that the choir was originally covered with a double quadripartite vault over each double bay, closely resembling the vault of the north transept, which indeed must have been erected almost immediately afterwards. The triple vaulting shaft in the centre of each bay might point to a minor transverse rib, were it not that no such rib is to be found in any of the other vaults over the main spans. The triple shaft probably received only the two diagonal ribs, and the double shaft which takes its place in the transepts was doubtless adopted as a more logical method of supporting the two ribs. The transverse section of the choir (fig. 8) shows how the vaults were abutted by semicircular arches beneath the triforium roof. The arch behind the vaulting shafts in the middle of the double bay is five feet in width, and springs from a pilaster on each side of the triforium. The back of the major pier is thickened by the addition of a broad pilaster next the triforium, with a second projection on its face to receive the abutting-arch, which is six feet one and a half inches wide (fig. 9). It is important to notice that these pilasters and the abutting-arches which they receive are part of the same work as the triforium itself, and not subsequent additions. The form of the arch is not well adapted to receive the thrust of the vault, and, in spite of the great thickness of the walls, the arches have actually undergone some distortion.

The east sides of the transepts follow the design of the choir almost exactly, except that the bays are much narrower and of irregular width,† and that a double vaulting-shaft is substituted in the triforium for the triple vaulting-shaft in the choir. The abutting-arches over the triforium form part of the original work, and, with the vaulting-shafts, prove that vaulting was contemplated when the eastern walls of both transepts were built. On the west walls of the transepts, however, we find only the triple shafts which receive the great transverse arches, but no shafts in the triforium to receive the ribs of the vault. It is clear that the idea of vaulting the transepts was temporarily abandoned when the west walls were built by the monks (there is reason to believe) between bishop William's death in 1096 and Flambard's accession in 1099. In the south transept, indeed, the clerestory was actually

* This is the case to some extent in other early plans of this type, e.g. the nave of Notre-Dame du Pré, Le Mans.

† This irregularity does not arise from any desire to build picturesquely, as some writers have fancifully sug-

gested. The width of the half-bay next the crossing is determined by the width of the choir aisle, and the three remaining half-bays seem to have been divided equally to the centres of the piers and the centre of the gable wall.

built with a continuous arcade, evidently to receive a wood ceiling, though there is no trace of anything of the kind in the north transept. It is equally clear that the vaulting idea was resumed while the work was still in progress. The simple character of the vault of the north transept (fig. 25), and the absence of the zigzag ornament which is used in the ribs of the nave aisle vaults, indicate that this transept must have been vaulted very soon after the completion of the choir vault in 1104. The double bay next the crossing is covered with a double quadripartite vault, without any intermediate transverse rib. The northern double bay is covered with a single quadripartite vault, an alteration evidently due to the extreme narrowness of the half-bays, and the double vaulting-shaft in the centre of this bay, which thus became superfluous, is simply carried up the wall to the crown of the vault. The section of the diagonal rib shows a large roll between two hollows (as in the aisles). The inner order of the transverse arch is similarly moulded, while the outer orders are square. The transverse arch is semi-circular; the diagonal ribs are probably segments of circles (as in the aisle vaults), but on account of the narrowness of the bays, especially of those next the crossing, the curves of the diagonal ribs are not very much lower than semi-circles. The vault cells



FIG. 25.—DURHAM, VAULT OF NORTH TRANSEPT (EAST SIDE). From a photo. by Mr. C. C. Hodges.

next the clerestory are twisted to a very considerable extent. In the narrow bays next the crossing the line of the vault on the clerestory wall is an extremely tall semi-ellipse. On the west side of the transept the diagonal ribs spring from corbels which have been inserted after the wall was built up to the clerestory string, though the wall of the clerestory itself is probably contemporary with the vault.

In the vault of the south transept the section of the diagonal rib shows a large roll with zigzags on each side of it. The inner order of the transverse arch has a large roll between two hollows (as in the north transept), but the outer orders are decorated with zigzags. With these exceptions, and the different construction of the clerestory already mentioned, the vault

of the south transept presents exactly the same characteristics as that of the north transept. It is evidently a little later in date, though still earlier than the nave vault.

In the nave we meet with the same abandonment of the vaulting idea, and its resumption while the work was still in progress, which characterises the transepts. The vaulting-shafts in the triforium of the choir are omitted in the nave, and the wall-face of the triforium is advanced to the face of the wall below, with an additional shaft supporting an additional order of the outer arch of the triforium openings. Consequently no shafts are provided to receive the diagonal ribs of the vault. There are some indications in the masonry of the clerestory of the two easternmost double bays which favour the idea that the clerestory was originally designed to receive a wood ceiling only. This is probable enough in itself, for we know that, even when the choir of a great church was vaulted, a wood ceiling was still the most usual covering for the nave and transepts. In this case Symeon's continuator expressly tells us that Flambard proceeded with the works *modo intentius modo remissius*, which would tend to render changes of design the more probable. It is quite clear that the triforium was completed up to the clerestory string before any preparation was made for the vault, for the corbels which receive the diagonal ribs have been inserted in the spandrels between the triforium arches. There can be little doubt, however, that the clerestory arcade was designed for, and is practically contemporary with, the actual vault.

The vault of the nave (fig. 26)* shows a very remarkable advance on those of the transepts. The semicircular curve is here employed, not for the transverse arches, as hitherto, but for the diagonal ribs—an advance which Viollet-le-Duc calls the only innovation of the first constructors of Gothic vaults.† The transverse arches thus become pointed, almost as a matter of course, though here the pointed arch is of a somewhat awkward form, owing to its being struck from centres considerably below the springing line. It may be freely admitted that this innovation in the construction of vaults did not at once produce in England the remarkable development which followed its adoption in the Ile-de-France, but this early example is valuable as proving the independence of efforts in the same direction by a school of builders which owed nothing to French influence. The nave, like the transepts, is covered with a double quadripartite vault over each double bay, without any intermediate transverse rib. The surface of the vault at the crown rises from the apex of each transverse rib to the key of the diagonal ribs. The line of the vault on the clerestory wall is a semi-ellipse, and there is no wall-rib. The transverse arches have an inner order moulded with a large roll between two hollows, flanked by an outer order ornamented with zigzags. The lowest voussoir of each outer order is wider than the rest of the arch, which may have been thus reduced in width in order to clear the springing of the diagonal rib more easily. The diagonal ribs have a large roll with zigzags on each side of it. The vault is abutted by half-arches across the triforium beneath the roof,‡ a far more effective method of receiving the thrust than the semicircular arch which is employed in the choir and transepts. These arches, which are five feet in width, spring from chamfered plinths projecting from the outer wall of the triforium; the plinth and the courses immediately above it appear to form part of the original structure, but the arches themselves seem to have been built when the vault was constructed. Similar rudimentary flying buttresses exist in the nave triforium of Sainte-Trinité, Caen.§

The nave vault of Durham has been persistently attributed to the middle of the thirteenth century, apparently on the strength of a vague statement in Leland's *Collectanea*.|| Billings

* I am indebted to Mr. C. C. Hodges, of Hexham, for permission to reproduce his photographs of the vaults of the transepts and nave (pp. 259 and 289, and figs. 25 and 26).

† *Dictionnaire*, iv. 35.

‡ Billings' *Durham Cathedral*, pl. xiii. xliii.

§ *L'Architecture normande*, i. 139, 141.

|| *Durham Cathedral*, by the Rev. W. Greenwell, 5th ed., pp. 37, 38. I am indebted to this excellent work for many references.

states that it was constructed between 1233 and 1244, in the Norman style,* which, if true, would be, as he calls it, a perfectly unique fact in the history of ancient architecture. As his error has been repeated by later writers who ought to have known better, it is necessary to assert positively that there is absolutely no authority for the statement. Apart from the fact that mediæval builders were not in the habit of imitating the work of a century before their time, the thirteenth-century vault over the choir shows what the nave vault would have been if it had been erected at the date which Billings assigned to it. The passages from Symeon's continuator already quoted prove that the nave was vaulted between 1128 and 1133. He tells us that Flambard built the nave *usque testudinem*, and that in the interval between Flambard's death (1128) and the accession of Geoffrey Rufus (1133) the nave was completed by the monks. Obviously the vault was all that was required to complete the nave, and the question is finally decided by the character of the masonry of the vault itself. The ribs have the characteristic diagonal tooling, and are built with the usual narrow stones, averaging about six inches in depth. The work presents the same characteristics as the clerestory, and has nothing in common with the works executed in and about the church by bishop Hugh de Puiset and his successors.

Durham, therefore, affords complete proof of the ability of Norman builders to construct ribbed vaults over the principal spans of a great church, and to abut the thrust of these vaults by arches across the triforium, of which the flying buttress is merely a development. The evidences already quoted indicate that the choir vault was constructed by 1104; the vault of the north transept may be assigned to a date within the first decade of the twelfth century, and that of the south transept within the first quarter of the century; while the nave vault, with its pointed transverse arches, was



FIG. 26.—DURHAM, NAVE VAULT (NORTH SIDE, THIRD DOUBLE BAY FROM CROSSING).
From a photo. by Mr. C. C. Hodges.

* Billings, *op. cit.* p. 16.

constructed between 1128 and 1133. The width of the span covered by these vaults is worth remark. The clear width of the transepts between the walls is 33 feet 9 inches (10^m 28), and that of the nave 32 feet 4 inches (9^m 85). In view of the exclusive claim advanced on behalf of the Ile-de-France for the discovery of the ribbed vault, a remark by M. Lefèvre-Pontalis may be noticed in this connection. He accounts for the fact that the naves of the rural churches of the Soissonnais, even in the second half of the twelfth century, were generally finished with wood ceilings by saying that the adoption of the ribbed vault at this period necessitated a nave of narrow span, and in support of this statement he quotes some of the early vaulted churches in the Beauvaisis,* which are only about as wide as the aisles of Durham.

In the priory church of Lindisfarne all the main spans were covered with ribbed vaults, which, like the general design of the church, are evidently inspired by Durham. The springings of the vaults of the choir, transepts, and crossing still remain. The choir was covered with quasi-quadrupartite vaults, *without* transverse ribs. The diagonal ribs are moulded with a roll between two hollows. Each transept was covered with a single quadripartite vault, with similarly moulded diagonal ribs. The ribs spring from corbels, both in the choir and transepts. The crossing also had a quadripartite vault, the diagonal ribs springing from corbels. One of these ribs is still standing, and has an inner order ornamented with zigzags and a moulded outer order. The vaults have no wall-ribs. Of the nave vault only a ring of stones of the cell abutting on the west wall remains. The work generally seems to be a little later than the nave of Durham, but no part of it appears to be later than the middle of the twelfth century.

Warkworth Church (Northumberland) presents an example on a small scale which is also quite clearly due to Durham influence. The chancel (32 feet by 16 feet 6 inches) of two bays is covered with a ribbed vault, of the quasi-quadrupartite form, originally without a transverse rib.† The ribs are received by short shafts which stand on the string which runs below the window-sills, the wall-face above the string being set back behind the wall-face below, exactly as in the triforium of the choir and east side of transepts at Durham. The shafts are single at each corner of the chancel, and double in the centre of the side walls, each shaft receiving a rib. The section of the diagonal ribs shows a large roll with a zigzag on each side of it. The diagonal ribs are segments of circles, struck from centres below the springing line. The setting-out of the vault was evidently governed by the semicircular chancel arch. The cells at the crown rise slightly towards the keys of the diagonal ribs (about 4 inches from the chancel arch, and 9 inches from the side walls). The line of the vault on the side wall is an upright semi-ellipse. The ribs are built of thin stones, averaging about 6½ inches in thickness. There is no wall-rib. The work may be dated approximately at 1120–1130.

Besides Durham the nave of at least one other great cathedral church was vaulted before the middle of the twelfth century. The nave of Lincoln (built by Remigius, and dedicated in 1092) was injured by fire in 1141, and Giraldus Cambrensis tells us that it was vaulted by bishop Alexander.‡ Henry of Huntingdon, who places the date of this work at 1146, says that Alexander made it more beautiful than when newly built, and second to no structure within the bounds of England.§ Only a fragment of the triforium of Remigius'

* *Op. cit.* i. 90. The width between the walls of the nave of Cambronne is 12 feet 10 inches (3^m 91), and of the nave of Bury 15 feet 9 inches (4^m 80). M. Lefèvre-Pontalis says that Cambronne cannot be later than 1125. Of the two rudimentary examples of the ribbed vault which he is inclined to attribute to the end of the eleventh century that of Rhuis, near Verberie, is a single bay of an aisle vault over a square of 2^m 20 (7 feet 2 inches), and that of Auviller, near Clermont in the Beauvaisis, is a tower vault with a span of 2^m 60 (8 feet 6 inches).

† The existing transverse rib is a later addition. The church will be illustrated and described in the forth-

coming volume of the *History of Northumberland*.

‡ "Ecclesiam tamen Lincolnensem casuali igne consumptam egregie reparando lapideis fideliter voltis primus involvit." *Giraldi Cambrensis Vita S. Remigii*, Rolls Series, ed. J. F. Dimock, cap. xxii. (vii. 33).

§ "Ecclesiam vero suam, quæ combustionem deturpata fuerat, subtili artificio sic reformavit, ut pulchrior quam in ipsa sui novitate compareret, nec ullius ædificii structuræ intra fines Angliæ cederet." *Henrici Archidiaconi Huntendunensis Historia Anglorum*, Rolls Series, ed. Thos. Arnold, pp. 278–9.

nave remains, in the bay between the western towers, and above is Alexander's clerestory, with the tall semi-elliptical line of the vault.* What this vault was like is fortunately indicated with some approach to certainty by the chancel of Stow church (Lincolnshire), the detail of which so closely resembles Alexander's work at Lincoln as to prove that it was executed by the same school of masons. The chancel of Stow is three bays in length, and 24 feet (7^m 32) in width. The bays are divided by triple wall-shafts, one shaft receiving each rib of the vault, and there is also a shaft in each internal angle at the east end to receive the diagonal ribs of the eastern bay. The vault itself is a modern reconstruction from rib stones which were found in the upper parts of the walls; some of the ribs have a roll between two hollows, and others are ornamented with zigzags. The evidence here indicates that the vault which Alexander constructed over the nave of Lincoln must have been a ribbed vault.

Such examples of ribbed vaults over main spans as the choirs of Kirkstall and St. Cross, where all the transverse arches are pointed, lie outside the limits of this paper. So far as my observation goes, the choir of St. Cross is the earliest English example which indicates that its designer knew anything of contemporary work in the Ile-de-France, although its details are English enough in character. The buildings in England of what is generally called the Transitional period still await analysis from this point of view, which would have to take into account not only undoubted influence from the Ile-de-France itself, but also the powerful effect of the Cistercian revival, which has scarcely been sufficiently recognised in this connection.

A few early examples of ribbed vaults to apses remain to be noticed. That of the small apsidal chapel on the east side of the south transept of Christchurch (Hants) appears to date from early in the twelfth century (fig. 27). The apse is divided into three bays by single wall-shafts on a square pilaster, and the ribs present the same section. The broad semicircular arch which opens into the apse is finished with a similar roll received by angle-shafts. The two ribs radiate to the crown of this roll, the key being one large stone. The ribs are constructed with the usual narrow stones. The apsidal chapel on the east side of the south transept of Tewkesbury abbey church has a vault of similar plan, with two chamfered ribs springing directly from the wall, and radiating to the crown of an unmoulded semicircular transverse arch. This vault may be assigned to the first twenty years of the twelfth century (the church was dedicated in 1123). A later example (middle of twelfth century) of an apse vault of similar plan is to be found in Birkin church (Yorkshire), where the ribs are moulded with triple rolls separated by fillets (fig. 29); the curve of the vault cell is generated by the semicircular window-arch, and the concave cells rise sharply towards the crown, giving the vault a quasi-domical effect. The same characteristic is presented by the octopartite vault of the Treasury of Canterbury Cathedral, although its plan is square, not apsidal.†

The apse vault of the Chapter-house of Durham Cathedral was a larger and more

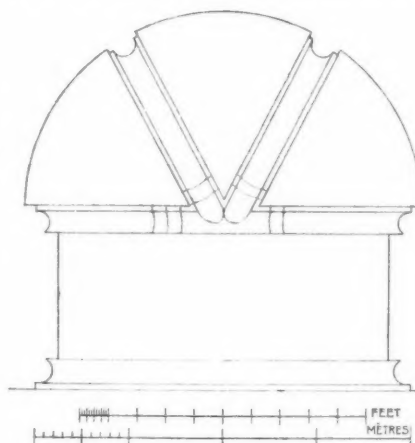


FIG. 27.—CHRISTCHURCH, CHAPEL ON EAST SIDE OF SOUTH TRANSEPT.

* *Archaeological Journal*, xl. 192, pl. ii. (A).

† Willis's *Monastery of Christ Church in Canterbury*,

fig. 6 and p. 77. The treasury was probably built soon after 1130.

advanced example, and one which, fortunately, is accurately dated. The Chapter-house was

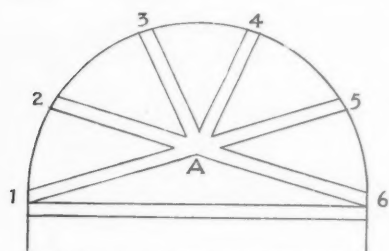


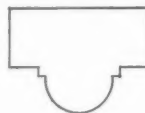
FIG. 28.—DURHAM, APSE OF CHAPTER-HOUSE.

finished by bishop Geoffrey Rufus, 1133–1140.* It was partly destroyed in 1796, but Carter's drawings have preserved an accurate record of it.† The apse was divided into five bays (fig. 28); the ribs of the vault sprang from large figure corbels, three of which are preserved in the Chapter Library, and the keystone of the vault still exists. The section of the ribs shows a roll between two rows of zigzags. The key, A, did not actually cover the centre of the apse curve, but the vault was set out by keeping the ribs 1 A 5 and 2 A 6 in straight lines on plan, the ribs being thus

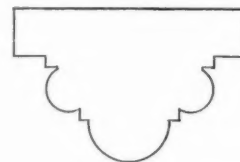
of unequal length. The width of the Chapter-house within the walls is 34 feet 6 inches (10^m 52).

It is only necessary to add a few words as to the bearing of the English evidence on the general question discussed in the first part of this paper. We have seen that, before the introduction of the rib, the Normans were already developing the articulation of their construction to an extent which (to judge from the early examples illustrated in M. Lefevre-Pontalis' work) was quite unknown in the Ile-de-France. The earliest ribbed vaults described above, in which the diagonal rib follows a segmental curve, exhibit a system which is slightly less advanced than even the primitive vaults over the aisles of Saint-Etienne, Beauvais, in which the transverse arches are stilted considerably, so as to admit of the diagonal rib being made semicircular, or nearly so. The large number of ribbed vaults still remaining proves the existence of an active school, which had already accomplished much before the introduction of the pointed arch. It is remarkable that all these English vaults are quadripartite. We have met with no example, either of the sexpartite vault‡ or of the intermediate form—a

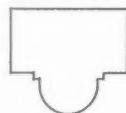
BERNIERES
NAVE AISLES



SAINT-ETIENNE, CAEN
NAVE



CANTERBURY
TREASURY



BIRKIN
APSE

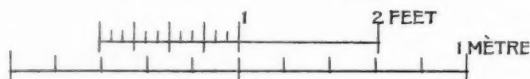
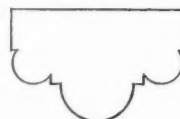


FIG. 29.—SECTIONS OF RIBS.

quadripartite vault over a double bay divided by a secondary transverse rib carrying a wall—both of which occur in Normandy itself, in the group of churches in and around Caen. Obviously the quadripartite vault was the earliest form, and (as Herr Dehio says) the other varieties could not have been developed if the quadripartite vault had not previously been known. The evidence of the rib sections points in the same direction. As in their system so also in the profiles of the rib mouldings, the earlier ribbed vaults in England which have been described above come into line with the quadripartite vaults at Lessay, and represent an earlier stage than the vaults of the Caen group. These latter, whether sexpartite or of the

* "Ipsius (Gaufridi) tempore capitulum monachorum consummatum est." Symeon, *Continuatio*, Rolls Series, ed. T. Arnold, i. 142.

† John Carter's drawings were published by the Society

of Antiquaries in 1801. An interior view of the Chapter-house is given in Billings' *Durham Cathedral*, pl. lii.

‡ I know of no sexpartite vault in England which is earlier than the work of William of Sens at Canterbury.

intermediate form (quadripartite cut by a secondary transverse rib), show one easily recognised type of rib section (fig. 29), a more refined and clearly later type, which we do not find in England until we come to the octopartite vault over the Treasury at Canterbury Cathedral, probably erected soon after 1130.* In the absence of any definite evidence, the approximate date of 1130 which has been suggested† for the earliest vaults of the Caen group, seems probable enough, and the experiments which the builders of these vaults tried in setting out the curves of the ribs indicate that they were not adopting ready-made a system already worked out elsewhere.

Even, however, if the English evidence alone is considered, the authenticated dates of the earliest ribbed vaults prove that influence from the Ile-de-France is quite impossible. They enable us to assert positively the complete independence of the Norman school, up to the end of the first third of the twelfth century at any rate. The question, How far were the beginnings of the French transition influenced by the neighbouring province of Normandy? is more difficult of solution. On *prima facie* grounds the influence would appear to have been much more considerable than most French archæologists have hitherto been willing to admit. It is the hope of contributing something towards a definite conclusion on this question which has induced me to attempt a systematic presentation of the English evidence.

DISCUSSION OF MR. BILSON'S PAPER.

Professor AITCHISON, R.A., *President*, in the Chair.

MR. R. PHENÉ SPIERS [F.], in proposing a vote of thanks to the author of the Paper, said that the principle which Mr. Bilson desired to set forth, if he understood him rightly, was to prove that the Norman vaulting in England was of an independent character, and was not necessarily copied or imitated from any examples in Normandy, but that, on the contrary, it was a probable development of some features a few years earlier than examples we were acquainted with in Normandy. Mr. Bilson had stated that the revival of architecture in Normandy seemed to have been commenced under Duke Richard II. The revival of architecture all through Europe commenced in the early years of the eleventh century, and so far as his own acquaintance with buildings in Normandy was concerned, if anything they were more behindhand than in any other part of France. The chief authority on this subject, M. Ruprich-Robert, had published a work on Normandy which they had in their library. It did not seem, however, that he was altogether sanguine as to some of the early dates given for Norman architecture. Among the illustrations of the early churches, the earliest at Querqueville was a tri-apsidal church with a square centre covered by a tower (showing that in the north of France, at all events, they had not adopted the dome which was found in the south), with three apses, one on the east side, one on the north, and one on the south.

The masonry in the church was of a very primitive character, of small stones sometimes in zig-zag courses, which distinguished work up to the end of the tenth century, and so far as he knew there was no other example in Normandy in which the same character was found. There was a second church of exactly similar plan—the small church of St. Saturnin, near St. Wandrille. He had not seen the church, but had examined photographs of it very carefully. There was no doubt that the work was of a much later date, although on the same plan. There was no small masonry. From the character of the moulding he thought that at the very earliest it might be 1030. Then there was the church at Bernay, which may have been built by Richard II., though it is said to have been commenced after his death. Ruprich-Robert published a bay of the nave, which he attributed to two periods, the inner shafts, capitals, and vaulting being of a later date. An illustration of the same was also given in De Caumont, and he attributed it to about 1050. The character of the carving in the capitals and the groining of the vault distinctly showed a later date, probably about 1050, and it seemed to indicate the influence of a different school of Burgundian origin. Mr. Bilson had arrived at the same conclusion. If that date be correct, it showed they were not very far advanced in that period in their architectural development, and it

* The profile from Saint-Etienne, Caen, illustrated here is found also in the arches of the nave arcade of New Shoreham church, which Mr. Edmund Sharpe assigned to c. 1130 (*The Architectural History of St. Mary's Church*,

New Shoreham, by Edmund Sharpe, 1861; supplemental sketch, p. 6).

† See note ††, p. 265 *ante*.

was not until one came to the work of William the Conqueror, ten or twelve years later, that the immensely rapid advance in which all the features were articulated and carried on separate shafts or piers, was found. In an important Paper read before the Institute in 1863,* the author, Mr. John Henry Parker, having made an accurate examination, arrived at the conclusion that the whole of the vaulting of the nave of the great church of St. Stephen at Caen (L'Abbaye aux Hommes) was long subsequent to the erection of the structure. He found traces of the original shafts which rose to carry the tie-beams. The conclusion arrived at by Mr. Parker was that this vaulting was not completed until about 1150, i.e. from twenty to forty years later than the date Mr. Bilson had given for the earlier vaults at Durham. Therefore one would be glad to know of the earlier vaulting, such as Lessay, which he had shown as an early example of vaults in France. In conclusion, Mr. Spiers said he had been especially struck with the great beauty of the photographs Mr. Bilson had put before the meeting, and the admirable way they illustrated his remarks. He was glad to have the privilege of proposing a very hearty vote of thanks to Mr. Bilson for his admirable paper, and the care and research he had given to the subject.

Mr. FRANCIS BOND, M.A. [H.A.], said he was very glad to have the privilege of seconding the vote of thanks to Mr. Bilson. All must recognise the enormous amount of care and labour that had been spent on the Paper. He happened personally to know that it represented many months of work. When it appeared in the JOURNAL with the illustrations and drawings, it would represent one of the most valuable contributions which had been made to the Institute TRANSACTIONS for very many years. It was a paper of exceptional importance. If what Mr. Bilson contended was correct as to the chronology of the choir-vault of Durham Cathedral, then they must come to the conclusion that the greatest work in mediæval architecture in Western Christendom was Durham Cathedral, and that its architect was a man they must put on a higher pedestal than the architect of Saint-Denis, or Vezelay, or of any other of the great churches where Gothic architecture had been supposed to originate. He himself should be glad to accept that view; but there seemed to be some difficulties in the way, which perhaps the author of the Paper might remove. In the first place, there was the old conflict between architectural and documentary evidence. Upon that he had the honour of speaking before the Institute at some length not long ago. He thought that the whole case with regard to Durham rested on a few words of a mediæval chronicler; especially on the words that the nave was finished *ad*

sui usque testudinem in the year 1128. One was scarcely justified, however, in assuming that the translation given to those words *ad sui usque testudinem* was necessarily the right one. They were always translated as if they meant that Durham Cathedral was finished up to the *vault* in the year 1128. But in mediæval builders' Latin *testudo* also applied to wooden roofs. In Mr. Bilson's own paper, in one of the notes, the phrase *lapideas testudines* occurred, with regard to the vault that fell at Durham in the thirteenth century. It seemed to show that the word properly applied to a ceiling either of stone or wood. Therefore, so far from it being necessary to believe that the *testudo* in Durham in 1128 was a stone vault, one was quite at liberty to suppose that it was a wooden ceiling of some sort. In the second place, he found it difficult to believe that in the year 1104 the high roof of Durham choir was one of stone. It would be a very remarkable thing indeed. Looking back at the vaults that had been constructed up to that date, it would be found that no such vault had been constructed anywhere up to 1104. Nothing like it had ever been put up. The points about it were: first of all, that it was a ribbed vault high up in the air, and a vault over a nave which had low aisles on each side—which added greatly to the difficulties of construction; that it was a vault that had clerestory windows inserted below it; and also that it was a vault divided into oblong compartments, which to mediæval architects were much more difficult to build than square ones. They bungled dreadfully over oblongs, and shirked them in all sorts of ways. There was not a single vault he could think of that triumphed over all these difficulties so early as the year 1104. The earliest main nave that was vaulted he supposed would probably be in one of the churches in Lombardy; perhaps the existing vault of the church of S. Ambrogio, Milan. This was supposed to have been put up between the years 1050 and 1100, which was anterior to the date given to Durham Cathedral. But that vault was much simpler and much more archaic. The ribs were heavy, clumsy, square ribs without mouldings; and the nave was divided, not into oblongs, but into squares. Moreover, in order to put up the Milan vault, the architect had to omit the clerestory; he wanted to keep the nave as low as possible, to make his work easy. And he constructed the aisles two stories high. So that by lowering the nave and raising the aisles he met the difficulty of abutment. Therefore this vault was not by any means of such an advanced character as the one at Durham of 1104. The next step made, perhaps, was the vaulting of the great Cluniac churches, e.g. Paray-le-Monial, and also the church of Saint-Etienne, Nevers. In those they had a high vault, and a clerestory underneath the vault. But the high vault over the nave in these Cluniac churches was generally a semicircular barrel—a much more archaic affair.

* "On the Abbey Churches at Caen," R.I.B.A. TRANSACTIONS 1863, p. 99.

The next step was seen at Vezelay. That also was a Cluniac church, but different from the other churches of the Order in having an intersecting high vault, like Saint-Nicolas, Caen; both are inferior to Durham in that the intersecting vault was merely a groined vault, and not a ribbed vault. These two Cluniac churches, Paray and Vezelay, were both dedicated in 1104. The vault of Vezelay was probably later than Durham choir in date, but was far less advanced in style. These seemed to him to be very important examples. They were churches the most advanced in style of their day. Durham choir, if it was of the date of 1104, was the first complete solution of the great medieval problem how to vault completely the whole of the spans of a church constructed on a basilican ground-plan, and with top-lighting, *i.e.* with clerestory windows. Thirdly, if the Durham architect had solved that great problem as early as 1104, one would imagine that all the medieval builders in England would at once have set to work to copy this vault. There the problem was solved; and one ought to be able to find in England especially, and also in France and Germany, any number of vaults constructed on the lines of Durham. But one did not find them. Mr. Bilson had given the instances of Lindisfarne and of Warkworth. Those churches were neighbours and appanages of Durham Cathedral; their chronology was uncertain, and he imagined stood or fell with that of Durham. The vaults in existence at Lindisfarne were over the transepts and chancel; at Warkworth over the chancel. Those two chancels and the transept were unaisled, and therefore not so advanced in character as Durham. The next example given was that of Lincoln nave. But that was gone; and one did not know what it was like. That could not be taken as evidence. It might have been a vault arranged in squares, and not in oblongs at all; it might have been half a dozen things. There was no evidence to show that it was so advanced in type as the vault of Durham choir. Passing on to such a vault as that of Kirkstall, Mr. Bilson said that it was possible that that vault was built in 1159, or earlier still. It was more likely to have been built after the year 1159; in any case they were getting a long way off from 1100. But even there the vault was not so difficult a matter as at Durham, because at Kirkstall the choir had no aisles. He did not know where to find any vault so advanced as this assumed choir-vault at Durham. Had they to go to Canterbury choir, vaulted about 1180, or to the Priory Church of Boxgrove or Chichester Presbytery, vaulted in the very last years of the twelfth century, before they found anything so advanced as at Durham? These difficulties seemed to be of considerable importance, and he should be glad if Mr. Bilson could prove that in spite of them one was right in claiming that the great problem was solved at Durham. As it stood,

there was nothing leading up to Durham. It was far more advanced than anything that had preceded it, although Norman architecture had only come into England some thirty years before. It was copied by no one for some forty years or more, and then only at Lindisfarne. Therefore, *à priori*, that is exactly the reverse of what one would have expected, as it seemed to him.

Mr. W. H. St. JOHN HOPE, M.A., said he should like to ask Mr. Bilson whether he had considered the case of Norwich. Norwich was a great church of the Norman period that was complete in all its parts, so far as the plan went, and the history of it was perfectly well known. It was true that the main spans were not vaulted until late in the fifteenth century, but we do not know that the presbytery was not vaulted from the first, because whatever roof it had was crushed in by the fall of the steeple in the fourteenth century, and again rebuilt by Bishop Goldwell. Norwich was begun by Bishop Herbert in 1096, and at his death, which occurred in 1119, he is said to have completed the church as far as the altar of the Holy Cross. So far as his (Mr. Hope's) knowledge of the church and its arrangements went, the altar of the Holy Cross would be situated about four or five bays down the nave: so that the bishop must have completed the whole of the eastern arm, the transepts, and the eastern portion of the nave. The work was carried on by his successor, Everard, who held the see from 1121 to 1145, when he resigned. He is said to have completely finished it. From the architectural evidence of the church it is clear that it was intended to be vaulted from end to end. The aisles throughout the church possess the vaults that were put upon them by their builders. They have the transverse arch and the unribbed groins, and they also have what does not occur even in Durham, a wall-rib, which is essentially a development of the earlier examples cited by Mr. Bilson. With regard to the central parts, the church is divided, so far as the presbytery and nave are concerned, into double bays like Durham. There are fourteen bays in all in the nave, which makes seven double bays, and in the presbytery there are two double bays with an apse beyond. The principal piers have on the nave side a very prominent vaulting shaft starting from the floor, consisting of two half-round shafts flanked by a nook shaft on each side. The intermediate piers have only a single half-round shaft, which also starts from the floor and runs up to the springing of the triforium arcade, where it ends in a capital of rather peculiar form. These features lead one inevitably to the conclusion that the main shafts in front of the principal piers were to carry a transverse arch, as at Durham. The nook shafts attached on either side were meant to carry ribs which would cross over to the shafts standing on the broad capitals at the springing line of the triforium arches. In fact, we should get exactly the same

arrangement as the Durham one, only probably of a plainer character. It is very unfortunate that disasters which befell the church at Norwich prevented this vault ever being completed so far as the nave and transepts were concerned. The transepts were evidently intended to be vaulted also, because the four bays of which they are composed are divided by broad semicircular shafts which run up in the same way as those in the nave, and were obviously intended to carry a vault somewhat of the same character as that of Durham. This evidence of vaults over the main spans is also corroborated by the evidence of the abutments. In the triforium all round the church, at the back of each of the piers, there occurs a tall shaft running right up almost to the level of the clerestory wall passage, and on the opposite wall there is a shaft of only half the height, showing that it was the intention of the builders to throw across a half arch, like those in the nave at Durham. So far as he (Mr. St. John Hope) knew, there was no proof all round the church of these abutments having been completed; certainly there was not one remaining. But there was all this architectural evidence, which, so far as he was aware, had not been noticed by anybody who had written upon the church. The very fragmentary paper Professor Willis left behind him did not refer to the fact in any way, although he gave a section of the presbytery which had upon it all the evidence which he had just described, including the half arch which was afterwards built to take the thrust of the later vault. These responds to carry the flying buttresses remained to this day all round the presbytery and down the south side of the nave, and in part along the north aisle, but on the outer wall of the north aisle they had been cut away and the scars plastered over. In any history of vaulting, this particular church, he thought, ought to be taken into consideration, although at the present day it exhibits a much more highly developed system.

Mr. E. W. HUDSON [A.], on the question of the locality where the great development in vaulting had its rise, thought it most likely that the schools of Europe reflected and re-reflected one upon the other, and gave rise to these changes in the system. Among the vast number of persons following the Crusaders across Europe there must have been some architects, who observed and noted, not only in France but in Normandy and Italy, the various devices adopted in the development of architectural work and, *inter alia*, its special vaulting characteristics. As a student he had endeavoured to follow Mr. Bilson's erudite descriptions and deductions, but it would take years to thoroughly investigate and follow out his observations. In going so far afield in one's researches one was apt to overlook the examples close at hand. As regards the diagonal rib, in the City of London and at Westminster there

were examples of vaulting which led the student very well from point to point. Some of these Mr. Bilson had referred to. One instance, however, he (Mr. Hudson) wished to draw attention to was not so well known as it deserved to be. In the crypt of the Priory of St. John's, Clerkenwell, there was a very fine example of the early ribbed vault which he should feel inclined to put some twenty-five years earlier than Rahere's unribbed work at St. Bartholomew's of 1123. That vault was worthy of close study. There were three bays of early date and two bays of transitional work. The early bays might be put at 1095, and, if that were the case, those ribs would show that we had in London a ribbed vault twenty-five years earlier than Rahere's work. The cross ribs were unusually large. They were made up of ashlar voussoirs on each angle with rubble between, and the plaster with which the web was covered was brought down over the cross ribs and finished in scollops. On the stone which was left bare there were even now traces of colour. On the diagonal ribs the plaster was brought down in a similar manner, and there finished with zigzags on the edges. One noteworthy peculiarity was that, although the cross joints of the keys were rectangular, in the other which abutted against it they were askew, differing from that illustrated by Mr. Bilson, which was more of a lozenge shape. The ribs sprang from a rectangular pilaster, and there was a thick abacus very similar to that upon the large crypt capitals of columns at Gloucester. The shaft was only two feet in height. If he were correct in the date he put upon this example there was a link in the chain of evidence which led students on fairly well until they came to the more advanced thirteenth-century work at Westminster.

Mr. JOHN BILSON [F.], after acknowledging the vote of thanks, said that Mr. Spiers was quite mistaken in thinking that he wished to claim for English Norman work any superiority over that of Normandy itself. The Caen group of vaults, in their system, were in advance of the English examples he had illustrated. M. Lefèvre-Pontalis assigned them to c. 1160, but M. Régnier thought 1180 a probable date. Herr Dehio had shown that the sexpartite and intermediate form found in that group could not have been developed unless the quadripartite vault had already been known. The English evidence clearly illustrated this earlier phase, represented in Normandy by the vaults at Lessay and other early examples; the authenticated dates of some of the English examples proved the impossibility of influence from the Ile-de-France suggested by M. Lefèvre-Pontalis, and confirmed Herr Dehio's opinions as to the position of the Norman school. With regard to Mr. Bond's remark that his (the speaker's) conclusions would attribute to a Durham architect the earliest solution of the problem of constructing a stone vault in oblong bays over a three-aisled church with clerestory, that was surely an over-

statement of the case. To take only one example from Normandy, that problem was solved with unribbed vaults in the choir of Saint-Nicolas, Caen, which dated c. 1083, some ten years before Durham was commenced. He was not surprised to find that Mr. Bond had some difficulty in accepting his conclusions as to the high vaults of Durham. When Canon Greenwell first drew his attention to the subject, he felt the same difficulty, but a prolonged study of the building had led him to believe that the conclusions which he had put before them were in the main the only possible deductions from the evidence. It was not a mere question of the interpretation of a single passage. The architectural evidence amply confirmed the dates suggested by the documents. What were the factors to be taken into account? 1. As to the choir vault, they had the undoubted fact that the choir was occupied in 1104; they had William of Malmesbury's story about the centering; the design of the choir pointed to a stone vault in the most unmistakable fashion; there was the evidence of the vault itself on the clerestory walls, and in 1235 the vault, which was then threatening to fall, was described as a stone vault which was built by the men of old, &c. 2. In the north transept they had the actual vault to which the whole design pointed as in the choir, and the character of the detail agreed with that of the earliest work in the church, that of the lower parts of the choir. 3. In the south transept they had similar vaulting, evidently a little later in date, and in character coming into line with Flambard's work in the aisles of the nave. 4. Then came the nave vault, with the pointed arch used tentatively. 5. Then the vaulting of the chapter-house, which, as told by a contemporary chronicler, was finished in the time of Bishop Geoffrey Rufus (1133-1140)—and here it would be found that, although the semi-circular transverse arch was still used, the detail of the zigzag showed a decided advance over that in the nave vault. 6. Then there were the high vaults of Lindisfarne, copying the system of the Durham nave, and it was impossible that the completion of that church (except alterations) could be placed later, at furthest, than the middle of the twelfth century. Mr. Bond had suggested in his recent book that the high vaults of Durham might have been built by Hugh Pudsey, c. 1160, but there was no evidence whatever to support that suggestion; the vaults showed a gradual advance which must have occupied some years; and their architectural character was utterly unlike Pudsey's works, of which several notable examples remained in the city and bishopric of Durham. He thanked Mr. St. John Hope for calling his attention to the evidence of the piers at Norwich, and he only hoped that his paper might lead to more careful investigations in directions which he had been unable to explore.

The following further contributions to the discussion on Mr. Bilson's Paper have been received:—

From Professor BALDWIN BROWN, M.A. [H.A.]—

Mr. Bilson's *résumé* of recent discussions on the origin of the Gothic style is particularly valuable, as bringing into light the extent and the intricacy of the questions at issue. The age of authority—represented, especially in this country, by Viollet-le-Duc—has passed away, and we are confronted by several contending theories advanced by French specialists, each of whom has dwelt on the evidence that accords with his personal theory. A broader and more satisfactory treatment of the whole matter has been supplied by the German authors of the *Kirchliche Baukunst des Abendlandes*; but even this book, indispensable as it is to the modern student, does not cover the whole field, and makes but a partial use of the English evidence which Mr. Bilson, in his second paper, has for the first time rendered fully available.

It is curious how Durham has been neglected by foreign writers. It lies a little to the north, but that ought not to be a real hindrance in the way of the study of a building extolled by Professor Freeman as forming with its adjuncts and surroundings the finest Romanesque monument in Europe, a building too which has a special importance in the history of construction. The fact that in the case of Durham literary sources of information flow pretty freely, makes it all the more instructive. The interpretation put on these notices in the paper may not all be absolutely conclusive, but Mr. Bilson has in each case drawn the most obvious and natural inference from the words, and never forced them into an unlikely, though possible, sense. The most important point of all is the one subject to the least doubt. That the nave vault is twelfth-century work, or, in other words, is as Norman as it looks, must be quite clear to any one who examines the workmanship of it.

The facts about the use of the rib in the groined vaults of the eleventh and twelfth centuries, which are now before the profession, should inspire some one to take up the whole question of the origin and history of this feature. Dehio and von Bezold (vol. i. p. 306) express themselves doubtfully about the reason for its adoption, and this would have to be considered in connection with the undergirding ribs of the Romanesque barrel vaults of the south and west of France, and their earlier employment in the Roman "Bath of Diana," at Nîmes.

The facts about the curves of the earliest known diagonal ribs under groined vaults which Mr. Bilson has recorded, have an important bearing upon the relation of the rib to the groin. The diagonal line of the groin is elliptical, but that of the earliest ribs appears to be, as a rule, segmental. Had the ribs originated from the desire either to strengthen the construction at the

line of junction of the vaulting fields, or—with a more æsthetic intent—to mark with decision the often irregular and uncertain arris of the groin, it would have been most natural for them to follow the elliptical curve of the actual diagonal. On the other hand, if they had been adopted ready-made, as they existed in barrel-vaulted buildings, the semicircular or segmental form would be, as a matter of course, retained.

A very curious instance of an early use of the diagonal rib occurs at Exeter, about which accurate information would be very desirable. In a vaulted undercroft in the existing fragments of St. Nicholas' Priory, dating from the early days of William Rufus, and of very rude and irregular construction, transverse arches are used throughout as in the undercroft at Westminster, but in the corner bays there are, in each case, single diagonal ribs under one of the two diagonal groins, but not under the other. The springing of these diagonal ribs in relation to that of the transverse ribs shows that they are contemporary with these and not afterthoughts, and the reason and function of them would be worth investigation.

Mr. Bilson, like Dehio and von Bezold, has no doubt about the intention of the Normans to vault all the main spans of their churches, and relies on the shaft which rises from the front of the main piers towards the roof, and which "can have no other motive than to support a vault," and "cannot have been the support of a mere tie-beam." There is, of course, a third alternative, that the shaft in question may have been planned to carry an undergirding arch such as occurs below the wooden roofs of Sta. Prassede, Rome, San Miniato, Florence, and nearer home at Notre Dame du Pré, le Mans, and elsewhere. Later on, the Normans adopted this form in the intermediate undergirding arch of quadripartite vaults, as at Bernières, near Caen, and it is conceivable that the arrangement of Notre Dame du Pré was contemplated at Jumièges. On the other hand, Jumièges shows the Norman predilection for stone roofs in its vaulted triforium, and this feature may even have occurred much earlier in the church dedicated at Fécamp in 990, under Duke Richard I., for a contemporary writer tells us that this was *duplīciter arcuatum mirabiliter*.

Mr. Bilson's careful and elaborate paper is a contribution of much importance to a controversy that will take some time to settle, for as a recent writer remarks: "The science of the Gothic style is still in its youth."

From W. Wonnacott [A.]—

With reference to Durham Cathedral, I was hoping that Mr. Bilson, in the early part of his paper, would have presented to his audience a plan of the church. There is one peculiarity of this design which, to my mind, has never yet been satisfactorily explained. That is the alternate grouped piers and cylindrical shafts, which

were used first in the choir by William of Saint-Calais in 1093; and six years later in the nave by his successor, Flambard. From end to end the design is the same, and Flambard adopted the plan of his predecessor for the completion of his work with but very minor constructive alterations. But we see, in the choir, how the large double bays were intended to be vaulted, triple shafts being attached to the walls over the cylindrical shafts for the avowed purpose of carrying a member or group of members of the intended vaulting. Mr. Bilson has shown also in the transepts similar evidence of an intended vault, at first temporarily abandoned, but ultimately adopted with the trifling variation of double (instead of triple) attached shafts at the triforium level, to carry some one or more of the vaulting members. But when we come to the nave, the cylindrical shafts occur without any evidence whatever that a stone vault was intended, not even the meaningless single shafts which run up to the roof in such examples as Ely and Peterborough, and also at Cézisy, and formerly at Norwich (anterior to 1446). Clearly the existing nave vault was not intended in its present form; was it to be a sexpartite vault (either pure or bastard), or was the nave to have a timber roof? Mr. Bilson will perhaps deny the former assumption, as he has already taken his ground [p. 318, *ante*] in stating it was much too early for a sexpartite vault, that "obviously the quadripartite vault was the earlier form," and summons Herr Dehio to support him in showing that the other varieties must have been developed from the quadripartite, and finally that we must all ultimately come round to this view, the only evidence he offers to effect this being the profiles of the rib mouldings.

But I should like it stated on clearer grounds than this why Mr. Bilson thinks the sexpartite vault or a timber roof could not have been here employed. Flambard in 1099 must have had some reason for perpetuating in his own work the principles expressed in that of his immediate predecessor. In the one case, it is clearly proved vaults were intended, and originally were constructed; in the other, perhaps, a similar construction was first intended and afterwards totally abandoned. But what was to be substituted?

Referring to the illustrations at the meeting, Mr. Bilson showed us first the ungroined vault, on the Roman model, without any transverse arches as at Caen (La Trinité), and then at one step we were taken through a series of illustrations in which the permanent centre, or *cut-stone arch*, was adopted, without any transition, as Canterbury crypt and Durham crypt. But Mr. Bilson leaves unexplored a rich field in omitting the very numerous examples of early Norman work where the arches were first formed in rubble, and were really parts of the web, also in rubble; these were then plastered to look like an

arch, but were not so in their true sense. There are many of these, some of them fine examples, still existing in crypts, chapterhouses, arched gateways, and chapels, such as Worcester, St. Peter's, Oxford; in the later ones we see the springings of these arches, and sometimes even of the vaults themselves, in *cut stone* (as Winchester crypt and transepts); sometimes the *groins* are in cut stone, the web and transverse arches being still in rubble. Another device, fruitful in examples, was the peculiar emphasis given to the wavy or ogee-like groins often to be found in the oblong and trapezoidal bays of Norman work, where the twisted groin was brought to a boldly projecting arris in the plaster, which gradually died away as it neared the key of the vault (examples at Worcester and Canterbury crypt). Willis has

expressed his opinion that the Normans were pleased with this form, and that it was appreciated and developed by them as an element of variety and beauty.

May I refer to a slight slip made by the author in that he refers to the ashlar springers of the vaults (p. 293) of Winchester crypt and transepts, 1079 and 1093 respectively; but in a footnote on p. 304 he states it was not till the end of the *twelfth* century that solid stone springers were introduced. The latter observation, I presume, refers to the *tas-de-charge* of ribbed vaults, though in both instances the constructive principle is the same.

I append a few dates in a tabulated form, believing they will be of assistance to students of our architectural history.

DATE	NAME OF WORK	DESCRIPTION OF VAULTS	BUILT BY	AUTHORITIES
1070	Canterbury	—	Lanfranc made arch-bishop.	
1070-1080	Westminster; undercroft of dormitory and refectory	Transverse arches and secondary pilaster.	Continuation of the Confessor's work.	
1072	Durham Castle: crypt.	Transverse arches.	Commenced by William the Conqueror.	
1073	Caen: choir of St. Stephen's consecrated.	—	—	<i>Chronicon S. Stephani Cadomiensis.</i>
1077	St. Alban's: aisles.	—	—	
1077-1082	Rochester: crypt under choir.	Groined, i.e. unribbed.	Bishop Gundulf.	See W. St. John, <i>Archæologia</i> , xlix. 32.
1078-1088	Lastingham: crypt.	Transverse arches.	By monks from Whitby.	
1079	Winchester: crypt; church commenced.	Transverse arches with secondary pilaster.	Bishop Walkelin.	
circa 1080	Tower of London: chapel aisles.	—	Bishop Gundulf.	
1081 (or 1073)	St. Stephen's, Caen: completed and dedicated.	—	—	<i>Chronicon Goferni.</i>
1084	Worcester: crypt.	Transverse arches in rubble.	Bishop Wolstan.	Willis. <i>Worcester Cathedral</i> . MS. dated 1092.
1088	Blyth church founded.	—	—	
1088-1091	Durham: undercroft of refectory.	—	During exile of Bishop William of Saint Calais.	Rev. W. Greenwell, <i>Durham Cathedral</i> . Willis.
1089	Gloucester: rebuilding commenced and eastern part completed by 1100.	Ambulatory of crypt unribbed.*	Abbot Serlo.	
circa 1090	Beauvais: St. Lucien's church commenced.	—	—	
1092	Lincoln: nave vault.	Ribbed vault, circular curves.	Bishop Remigius.	
1093	Durham: foundation stones laid, choir and aisle vaults commenced.	First use of ribbed vault triple shafts to receive ribs.	Bishop William of Saint-Calais.	
1093	Winchester: monks completed church.	—	Bishop Walkelin.	
1096	Durham: Symeon's History ends in this year—aisle vaults of choir completed.	—	Bishop William died.	
1096	Canterbury: crypt.	Transverse arches—plastered.	Bishop Ernulf.	Willis.

* Diagonal ribs here are later work, probably 1100-1115.

DATE	NAME OF WORK	DESCRIPTION OF VAULTS	BUILT BY	AUTHORITIES
1099	<i>Durham</i> : choir and transept vaults completed and nave aisle vaults commenced.	Ribbed vaults, triple shafts employed (except to cylindrical nave piers).	Ralph Flambard became bishop.	
1100	Gloucester: choir dedicated, nave commenced.	Ribbed vaults to aisles, circular curves.	Abbot Serlo.	
1100-1107	Ely: nave and aisles.	Transverse arches, with shafts supporting the groins.	Design attributed to Abbot Richard; probably not entirely carried out by him.	Rev. D. J. Stewart, <i>Ely Cathedral</i> .
1104	<i>Durham</i> : main vault of choir completed and translation of St. Cuthbert's body to the shrine.	—	Ralph Flambard proceeding with the nave.	
1107	Winchester: central tower fell. Transept and aisle vaults partly reconstructed.	Ribbed vaults.		
1107-1110				
circa 1110	Romsey Abbey: choir aisles (in early work).	Unribbed intended, but ribs used; one shaft only.		No documentary evidence.
1114	Rochester.	—	Ernulf became bishop.	Willis.
1116	Peterborough burnt.	—		
1117-1118	Peterborough: present church commenced.	Ribbed vaults, circular curves.		
1120	St. Aignan-la-Cité: chapel.	Unribbed.		
circa 1120	Morienval.	Ribbed, circular curves.		
circa 1120	Southwell.	Ribbed vaults, circular curves.		
circa 1120-1130	Warkworth church.	Ribbed.		
1123	St. Bartholomew, Smithfield, founded.			
1123	Tewkesbury dedicated.			
circa 1124	Dunfermline.	Ribbed, circular curves, triple shafts.		
1125	Cambronnes-les-Clermont.			
circa 1125-1130	Devizes. St. John's and St. Mary's: chancels.	Ribbed vaults, circular curves and clustered shafts.		
1128	<i>Durham</i> : nave vault commenced.	Ribbed, pointed arches.	Bishop Ralph Flambard died.	
circa 1128	Lindisfarne.	Ribbed circular curves, triple shafts.	Edward.	Reginald of Durham. MS. 1165 A.D.
circa 1130	Vezelay: porch.	Pointed arches, groins unribbed.	—	Viollet le Duc, <i>Construction</i> .
1133	<i>Durham</i> : nave vaults completed, chapter house vaulted.	Ribbed circular curves.	Geoffrey Rufus succeeded Flambard.	
1137-1140	Saint-Denis: vaults under west towers.	Arches all pointed.	Suger's work.	Viollet le Duc.
circa 1139	Malmesbury: nave aisles.	Ribbed diagonal, semi-circular, pointed arches, triple shafts on walls.	Attributed to Bishop Roger (died 1139).	
1140 or 1143	Peterboro': choir and part of transepts completed and monks entered church.	Ribbed circular curves, triple shafts on walls (not on piers).		
1140	Sens commenced. St.-Denis narthex completed.			
1141	Lincoln: nave burnt, new vaulting.	Ribbed.	Bishop Alexander.	<i>Giraldus Cambrensis</i> .
1144	St.-Denis: choir completed.			



9, CONDUIT STREET, LONDON, W., 25th March 1899.

CHRONICLE.

President of the Glasgow Institute elected Fellow.

The Council, at their meeting of the 6th inst., acting under the proviso to By-law 9, whereby they are empowered to elect to the Fellowship the President of any Allied Society who is eligible and applies for admission, duly elected the following gentleman Fellow of the Royal Institute:

DAVID BARCLAY, of 245, St. Vincent Street, Glasgow, President of the Glasgow Institute of Architects.

The New Vauxhall Bridge.

In consequence of the letter of protest published in *The Times* of the 6th inst. [p. 275], Mr. Ward, the Chairman of the Bridges Committee, made a statement at the meeting of the London County Council on the 7th inst., to the effect that several deputations from the Art Committee of the Institute had been received by the Bridges Committee, and that the engineer had received a letter from Mr. A. Waterhouse, R.A., congratulating him on his design. By way of public rejoinder to this statement, the following letter addressed to the Clerk of the London County Council by the Secretary of the Institute on the 21st February was published in *The Times* of the 10th inst.:-

"The Council of the Royal Institute of British Architects has had before it your letter of the 30th ult., and I am directed in reply to point out that the request of my Council was that the Chairman of the London County Council should receive a deputation, whereas the matter seems to have been referred only to the Bridges Committee. I have to state also that the communications which have passed between this Institute and the London County Council—dating back to 1894—have been almost entirely confined to the construction of an iron bridge with stone piers, a form of construction originally insisted upon by the Bridges Committee, but subsequently abandoned. Of such a bridge my Council laid before the Bridges Committee (at the Bridges Committee's request), with certain suggestions, draw-

ings and details to scale, and not only a sketch as stated in your letter. Details, suggestions, and criticisms dealing with an iron structure are not, however, applicable to one completely dressed in stone, and the only inter-communication afforded by the engineer in reference to the stone-clad design (recently made public) has been the interview alluded to in your letter between Sir A. Binnie and Mr. Waterhouse and Mr. Mountford, which interview was, at Sir A. Binnie's instance, to be considered informal and confidential. My Council much regret, upon public grounds, that the London Council has refused to see a deputation which would have expressed the views of many of the leading architects of the day upon the design for so costly and important a public monument. At the same time, I am to express surprise that the London County Council should have fallen back upon an expressly confidential letter and interview to base its refusal, more especially when my Council have had no opportunity of seeing the design or forming an opinion upon it until its recent publication. It appears, moreover, that the suggestions made by Mr. Waterhouse and Mr. Mountford for rendering the design less objectionable (which were more far-reaching than might at first sight appear) have been entirely ignored, and Mr. Waterhouse states that an interpretation has been put upon his letter which he never intended to convey. The Royal Institute of British Architects, having much at heart the architectural quality of the public monuments of London, greatly regrets the unwillingness of the London County Council to reconsider a design which is undignified and unworthy of its destiny, and will, in spite of the costly nature of its architectural accessories, reflect so little credit upon contemporary architecture, upon London, and upon the London County Council."

A deputation of the Institute was received by the Chairman of the London County Council on the 10th inst., and their report is now under the consideration of the Council.

The New A.R.A.

At a General Meeting of Academicians and Associates of the Royal Academy, held on Thursday evening the 23rd inst., Mr. Aston Webb [F.] was elected an Associate.

The Northern Architectural Association.

Mr. W. Glover, recently installed in the Presidential chair of the Northern Association, is prepared to give generous aid towards the attainment by the Association of the following desirable objects:—(1) A building to be its home; (2) a good library; (3) prizes for students. For the first he offers 100 guineas if members will raise 900; for the second he promises 25 guineas if members will contribute 75; and for the third he will give 25 guineas if members will give 75. He

further offers to double his donations if members will double their help. This would raise 2,000 guineas for the building, 200 guineas for the library, and 200 guineas for a students' fund, the interest of the latter to be devoted to prizes. Mr. Glover, it will be remembered, a few months ago presented the Association with a new Presidential Badge, which was illustrated in the last volume of the JOURNAL, p. 207.

Secret Commissions.

In the last issue of the JOURNAL (p. 283) reference was made under the above heading to a letter from a firm of billiard-table makers, offering a Fellow of the Institute a commission of 5 per cent. Another, though not so flagrant an instance of bribery has since come to hand in the shape of a trade circular from Messrs. Carver and Company, a firm of wall-paper manufacturers in Berners Street, enclosing a leaflet that bears the legend:—"A Free Gift to Architects. Owen Jones's *Grammar of Ornament*. 5 guineas Edition. Architects desiring the above work would oblige by making written application for same." Perhaps firms who advertise by these methods do not realise that they are insulting a professional man by sending him such a circular.

Obituary.

News has just been received of the deaths in September last of Frederick Mew, of 9, Gordon Street, W.C., and William Reddall, of 10, South Street, Finsbury, E.C. Mr. Mew was one of the oldest Associates of the Institute, having been admitted in 1859. Mr. Reddall had been an Associate since 1874.

LEGAL.

THE LONDON BUILDING ACTS.

Building Line.

At the Clerkenwell Police Court, on 8th March, Mr. Horace Smith had to determine a dispute between the London County Council and Mr. W. H. Scott, of the Vernon Arms, Pentonville, arising on an objection in writing, under section 150 of the London Building Act, 1894, to the erection by him of 180 and 182 Pentonville Road. The material facts, as stated to the Court by counsel for Mr. Scott and reported in the *Law Journal*, are as follows:—The appellant was desirous of pulling down and rebuilding Nos. 180 and 182 Pentonville Road, No. 180 being the Vernon Arms, at the corner of Southampton Street. The houses between Southampton Street and Winchester Street, leading from Pentonville Road, were some set back with a forecourt, and others flush up

to the pavement. Mr. Scott applied to the Council in July last for leave to build, when assent was withheld on the ground that they proposed to disturb the line of building. The appellant then petitioned to "deviate" under section 43 (2) of the Act. To this the Council replied that the proposed deviation was not such as was contemplated under the section, and that therefore they had no power in the matter. They declined to give a decision. The result was that Mr. Scott was prevented from applying to a tribunal of three experts as provided for in the Act. The County Council next called upon the superintending architect to define the building line between Southampton Street and Winchester Street, and certified that the main frontage of the buildings formed the general line of building. But the superintending architect omitted all reference to section 22 (2), which said that section 22 should not apply to any buildings erected seven years prior to the commencement of the Act of 1894. These buildings existed long before seven years prior to the Act. Mr. Scott, taking the next step necessary, served a building notice upon the surveyor, and the surveyor refused his consent to the proceedings because they proposed to build beyond the line of building without the consent of the County Council. This brought the case to that Court. It was contended for the Council that the architect had not defined his own line of building, but the line of building as it existed. The whole question was, were these buildings "lawfully" occupied as meant in section 22 (2)? Their erection had never been sanctioned, and an old Act of 1756 prohibited building within fifty feet of the centre of this road. In the reign of George IV. this Act was repealed, and another passed prohibiting buildings within forty-six feet of the road centre. That Act remained in force until the Metropolis Management Act of 1862. No one could acquire a prescriptive right against the Crown, so that the fact that these buildings had been allowed did not affect the case. The fact that they had not been sanctioned by the old Metropolitan Board of Works showed that they were not lawfully erected within the meaning of the Act.—Mr. Horace Smith decided in favour of the Council, but offered to state a case for the High Court.

MINUTES. X.

At the Tenth General Meeting (Ordinary) of the Session 1898-99, held Monday, 20th March 1899, at 8 p.m., Professor Aitchison, R.A., *President*, in the Chair, with 14 Fellows (including 7 members of the Council), 22 Associates (including 1 member of the Council), 1 Hon. Associate, and several visitors, the Minutes of the Special and Ordinary Meetings of the 6th March [p. 287] were taken as read and signed as correct.

The decease was announced of Frederick Mew and William Reddall, *Associates*.

The following Associates, attending for the first time since their election, were formally admitted and signed the Register—viz. Arthur Maryon Watson, B.A., Ernest Jesse Mager, and Rupert Claude Austin.

A Paper by Mr. John Bilson [F.] ON NORMAN VAULTING IN ENGLAND having been read and illustrated by lantern slides, a discussion ensued, and a vote of thanks was passed to the author by acclamation.

The proceedings then closed, and the Meeting separated at 10.15 p.m.

